# THE AMERICAN ENERGY INITIATIVE, PART 17: A FOCUS ON THE FUTURE OF ENERGY TECHNOLOGY WITH AN EMPHASIS ON CANADIAN OIL SANDS

## HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND POWER

OF THE

COMMITTEE ON ENERGY AND COMMERCE

HOUSE OF REPRESENTATIVES

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# C O N T E N T S



[1] The report is available at http://www.eipa.alberta.ca/media/39640/life%20cycle%20analysis%20jacobs%20final%20report.pdf.

# THE AMERICAN ENERGY INITIATIVE, PART 17: A FOCUS ON THE FUTURE OF ENERGY TECHNOLOGY WITH AN EMPHASIS ON CANADIAN OIL SANDS

**TUESDAY, MARCH 20, 2012**

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY AND POWER,
COMMITTEE ON ENERGY AND COMMERCE,
*Washington, DC.*

The subcommittee met, pursuant to call, at 10:04 a.m., in room 2123 of the Rayburn House Office Building, Hon. Ed Whitfield (chairman of the subcommittee) presiding.

Members present: Representatives Whitfield, Shimkus, Terry, Bilbray, Scalise, McMorris Rodgers, Olson, McKinley, Gardner, Pompeo, Griffith, Castor, Engel, Green, and Waxman (ex officio).

Staff present: Charlotte Baker, Press Secretary; Michael Beckerman, Deputy Staff Director; Maryam Brown, Chief Counsel, Energy and Power; Allison Busbee, Legislative Clerk; Garrett Golding, Professional Staff Member, Energy and Power; Cory Hicks, Policy Coordinator, Energy and Power; Ben Lieberman, Counsel, Energy and Power; Carly McWilliams, Legislative Clerk; Phil Barnett, Democratic Staff Director; Caitlin Haberman, Democratic Policy Analyst; Angela Kordyak, DOE Detailee; and Alexandra Teitz, Democratic Senior Counsel, Environment and Energy.

## OPENING STATEMENT OF HON. ED WHITFIELD, A REPRESENTATIVE IN CONGRESS FROM THE COMMONWEALTH OF KENTUCKY

Mr. WHITFIELD. I would like to call this hearing to order this morning. I might say that this is the 17th day of hearings that we have had on energy in America.

Frequently, President Obama in his speeches talks about America having only 2 percent of the world's proven oil reserves. Today, we are going to discuss how Canada took action to increase its proven reserves several-fold by allowing the development of oil sands in Alberta. We know that in Canada and in the U.S., there have many groups that have opposed additional oil production in both countries, but Canada faced that situation and as a result, as I have indicated, dramatically increased their proven oil reserves.

As a result of that, those of us in America, many of us, are going to continue to advocate for the Keystone XL Pipeline Expansion project that could bring an additional 700,000 barrels of oil a day to Midwestern and Gulf Coast refineries from Canada. The benefits

in terms of additional secure oil and thousands of jobs is simply too important for us to give up on. I for one would like to see more Canadian oil flowing into America. I would also like to see the same type of pro-energy agenda in America that made oil sand production possible in Canada.

There is a bountiful supply of untapped oil reserves here in the U.S., but frequently, it is too bottled up with Federal access restrictions and regulatory red tape. And I believe this needs to be changed. And the development of oil sands in Canada provides many lessons for us here in America.

In spite of regulatory obstacles to additional development and production in the U.S., we do see signs of the can-do spirit in America. For example, new drilling techniques pioneered in the U.S. have turned North Dakota into a major oil-producing State. But that was possible only because it was developed on private lands, not Federal lands. In the vast areas of America where we have public lands and oil in these areas, the Obama administration has been reluctant to give the go-ahead for additional exploration and production in those areas.

I am sure the Canadian people care about the environment every bit as much as we do in America, and they have insisted all along that oil sands production be done in an environmentally safe way. We will learn today about the successful efforts to reduce environmental impacts from oil sand even as the production of oil sands increases through technology. The difference is that Canadian regulators seek to make energy production safe while the Obama administration regulators often seek to make it impossible to do. That is why Canada's oil sands is nearly as valuable as an example of energy policy done right as it is for the oil itself. America can and must increase its domestic energy production and there is much that we can learn from the Canadian experience. And I look forward to the testimony of all of our witnesses today on that very subject matter.

[The prepared statement of Mr. Whitfield follows:]

**Opening Statement of the Honorable Ed Whitfield**
**Subcommittee on Energy and Power**
**Hearing on "The American Energy Initiative: A Focus on the Future of Energy Technology with an Emphasis on Canadian Oil Sands"**
**March 20, 2012**

This is the 17th day of our hearing on the American Energy Initiative.

President Obama has given many energy speeches in recent weeks, and every time he laments that America has only two percent of the world's proven oil reserves - as if there's nothing we can do about it.

Well today we are going to discuss how Canada took action to increase its proven reserves several-fold by allowing the development of oil sands in Alberta.

Energy naysayers would have never imagined a new source of North American oil so big that it would require increased pipeline capacity to handle it.

But that is exactly what has happened with Alberta's oil sands, and we will continue to fight for the Keystone XL pipeline expansion project that would bring an additional 700,000 barrels per day of this oil to Midwestern and Gulf Coast refineries. The benefits in terms of additional secure oil and thousands of jobs are just too valuable to throw away.

There is no question that I would like to see more Canadian oil flowing into our country. But there's something else I would also like to see coming here – a pro-energy agenda that made oil sands production possible. There is plenty of untapped oil here in the U.S. – but all-too-much of it is bottled up by federal access restrictions and regulatory red tape. This needs to change, and the development of Canada's oil sands provides many lessons as to how to go about it.

In spite of regulatory obstacles to additional development and production here in the United States, we do see some signs of the can-do spirit in the American oil industry.

For example, new drilling techniques pioneered in the U.S. have turned North Dakota into a major oil producing state.

But that was possible only because the land there is not controlled by the federal government. In the vast onshore and offshore areas where the Obama administration must give the go-ahead before exploration and production can commence, the answer is usually no.

I'm sure the Canadian people care about the environment every bit as much as Americans do, and they have insisted that oil sands production be done safely.

We will learn today about the successful efforts to decrease the environmental impacts from oil sands even as production increases through technology.

The difference is that Canadian regulators seek to make energy production safe, while the Obama Administration's regulators often seek to make it impossible.

That is why Canada's oil sands is nearly as valuable as an example of energy policy done right as it is for the oil itself. America can and must increase its domestic energy production, and there is much to learn from the Canadian experience as to how we can get there.

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Mr. WHITFIELD. At this time I would like to recognize the gentlelady from Florida, Ms. Castor, for a 5-minute opening statement.

**OPENING STATEMENT OF HON. KATHY CASTOR, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF FLORIDA**

Ms. CASTOR. Well, thank you, Mr. Chairman. And thank you to the witnesses who are here today.

Today, we are having a hearing on tar sands and we are going to hear testimony about how the production and use of tar sands fuel exacts a very heavy toll on the environment and on communities, whether it is impacts to water quality or strip mining or the very serious carbon pollution. This is dirty stuff. Do we have the technology to address these issues? It is not clear at this point that we should be going gangbusters, full speed ahead, until we really can address the economic and environmental impacts of tar sands.

As one of our witnesses will testify today, from the production well to the wheels of a car, tar sands fuel is estimated to generate about 23 percent greater carbon pollution than conventional oil. These are very serious issues and we need to get ahead of them and not stick our heads in the sand so to speak and play ostrich with this. This could be very beneficial for our energy production strategy, but it can't come at such a high cost that communities suffer, the environment suffers, that we pollute our water, we pollute our air.

One of the worst impacts could be to the climate. And colleagues, we have a responsibility to understand the impacts to the world's climate because climate change does threaten our public health, it threatens our economic security, it threatens our agricultural production and our national security. Those are just some of the threats posed by climate change. And in some ways, this hearing is a first step. We are finally hearing about how much carbon-intensive tar sands fuel is and we are hearing about some of the technologies that could be used to reduce that carbon pollution if we are really serious, if the United States and Canada are really serious about reducing those impacts.

There are other very serious issues. I know process isn't all that exciting, but we need to be mindful that we have very important pipeline systems all across this country and throughout Canada and they work well, but what is the difference here? They have been subjected to appropriate environmental review and they have been subjected to certain safety standards. And I am afraid the majority party's push to override those considerations will eventually come at the detriment of our communities throughout both countries. So we have a responsibility to follow the law and not override these important environmental laws and community safety laws that every other business has been subjected to.

I am also at a loss frankly that throughout the entire 112th Congress, the majority of this committee has made no effort to consider a comprehensive energy strategy, one that puts everything on the table, one that seriously examines the proper places to invest for a truly diversified energy supply. Until we do that, these issues will continue to be debated pipeline by pipeline and coal plant by coal plant and that really doesn't make sense. It is past time for

this committee to examine these issues with the seriousness they deserve.

I yield back.

Mr. WHITFIELD. At this time I recognize the gentleman from Illinois, Mr. Shimkus, for 5 minutes.

**OPENING STATEMENT OF HON. JOHN SHIMKUS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ILLINOIS**

Mr. SHIMKUS. Thank you, Mr. Chairman. Thanks for calling the hearing. It is good to continue to talk about energy security and lower-priced crude oil, lower-priced gasoline, decrease in our reliance from Iran, decrease in our reliance from the Strait of Hormuz, countries that dislike us and looking north to our friends and allies, the Canadians, who I would make a point that there are no better environmental stewards than any country on Earth.

And so let me start by—I have got a couple slides based upon my trip. First, I am going to put up the pipeline issue that I addressed at a hearing before. Look at all of the pipelines we have in this country today. Why do we have pipelines in this country? Because it is the safest, most secure way to transport liquid product, whether that is crude oil, refined product. If you have ever been to a refinery, you don't see trucks going in and out because pipeline is bringing the crude, pipelines send out the broken up component parts of the refined product.

In the last hearing we talked about the numerous pipelines we already have across the Canadian-U.S. border also on the Mexican border. Next slide.

[Slide.]

Caterpillar, a great U.S. company, one of our largest exporters, relies on Canadian oil sands mining for building these great pieces of manufactured—we talk about manufacturing in this country. That is manufacturing. Our Michelin tires made in South Carolina, we are proud from Illinois, and I am proud of Caterpillar and their ability to work in this operation. Next slide.

[Slide.]

Ford trucks, Ford 150 trucks all over Fort McMurray, that is at one of the oil sands mining operations, a good American-made, probably built by United Autoworkers. It is great to see up there. Next slide.

[Slide.]

Traffic jams, if you have been to Fort McMurray, it is a little podunk town—well, it was a little podunk town. Now, you have traffic jams. And if you look to the left, those are two Harley-Davidson motorcycles, nice to see American-made products up in Canada. Next slide.

[Slide.]

That is a mining operation, and this is a good point. I want to put this up because what we are going to hear today is about a different type of oil sands recovery that creates a carbon footprint less than the California standards. This is what you will hear debated. You won't hear anybody talk about what we are going to hear testimony about. Next slide.

[Slide.]

Another mining operation. I am from mining country in Illinois. I love surface mining; I love subterranean mining, good jobs, good salaries, good health benefits. And I think that is the last slide. I wanted to have an in situ slide but I think for most people it would be very disappointing. And hopefully we can get a slide up later on in the questioning because if you see in situ operation, what are you going to see? You are going to see a platform, maybe the sides, a coverage area, maybe three football size long. You are going to see a couple buildings and you are going to see pipes. That is all you are going to see. You are not going to see a big footprint. And you are going to see geothermal applications that create a smaller carbon footprint.

And I am not a big carbon guy, OK? If you follow my public testimony and my comments, this climate change thing, pricing carbon, I am not in that camp. But if you go in that direction, 80 percent of this oil sands recovery can be in situ, and that is what I hope my colleagues on the other side learn about today. Two different types of recovering oil sands, mining operations, in situ. Eighty percent of the oil up there now is in situ and it is in pipelines and there is no footprint.

So Mr. Chairman, great to have the hearing today. American jobs, Canadian jobs, third-largest oil reserves on the planet. To our neighbors and friends, the Canadians, a democratic country, if you look at the top 10 how many are free capitalist societies, free market ability to grab crude oil, the oil sands is one area. We need to work with our allies and friends the Canadians to recover that. It will decrease our reliance on imported crude oil and lower our prices.

Thank you. And I yield back my time.

Mr. WHITFIELD. Thank you, Mr. Shimkus.

At this time, I recognize the gentleman from California, Mr. Waxman, for 5 minutes.

**OPENING STATEMENT OF HON. HENRY A. WAXMAN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA**

Mr. WAXMAN. Thank you, Mr. Chairman.

Today's hearing will examine the production of fuel from tar sands, the technologies used in that process, and the environmental impacts of tar sands development.

The Republicans and the oil industry will use this opportunity to call for building the Keystone XL tar sands pipeline and developing deposits of tar sands and oil shale in the United States. They will base these recommendations on two central claims. First, they will say that we can reduce gasoline prices by expanding production, including developing unconventional deposits such as tar sands and oil shale in the United States. And second, they will suggest that the environmental effects of developing tar sands are not that bad and getting better. My response is, don't believe them.

Let us consider gas prices. It is a Republican article of faith that we can drill our way to lower prices at the pump. But as we heard at the recent hearing on gas prices, if we increase production, it is easy for OPEC countries to reduce production by the same amount.

That is the definition of a cartel—a group of entities that coordinates to control prices.

The fact is we are drilling more and prices are still going up.

U.S. crude oil production is the highest it has been in 8 years, and the U.S. has more oil and gas drilling rigs operating right now than the rest of the world combined. Net oil imports as a share of our total consumption declined from 57 percent in 2008 to 45 percent in 2011, the lowest level since 1995, but prices are still going up.

In fact, Canada is the poster child for the point that more production will not free us from world oil prices. Canada has huge tar sands deposits and is developing them at a breakneck pace. Canada is a net exporter—that means they produce more oil than they use.

And I want to put up a chart that shows what has happened since 2000. Canada's production and net exports have increased steadily for the past 12 years. Canada has increased its crude oil production by more than 35 percent. Canada is producing so much oil that it now exports 70 percent of all the oil they produce.

If everything the Republicans have been telling us is true, then gasoline prices in Canada should have plummeted over the last 10 years. But that is not what happened.

Here is another chart I would like to have up. And this shows the U.S. and Canadian gas prices over that period. As you can see, U.S. and Canadian gasoline prices track perfectly because they are both driven by the same thing—world oil prices. In fact, Canada's gas prices are actually higher than our prices due to taxes.

More drilling, building a new tar sands pipeline or developing oil shale has not reduced gasoline prices in Canada and it won't in the United States either.

But that is not the only fantasy we will hear about today. We will also hear that the environmental harms from tar sands production have been minimized and will be solved by technology. In reality, the tar sands operations have vast and devastating effects on the land, water, air, and ecosystem.

Canadian tar sands are produced in Alberta's boreal forests. And the photo I would like to have put up you can see a pristine area before tar sands production begins. The landscape is beautiful. The air and water are clean.

In the second photo of which we can put up you can see the effects of tar sands production. The land has been turned into an industrial wasteland. The forests have become an open pit mine. Maybe some of this damage can be avoided. Technology can reduce environmental impacts. But that won't happen without stronger government regulation.

I recognize that tar sands holds a large amount of oil. But it is a resource that should not be exploited without environmental safeguards that protect that land, water, and pollution, controls that stop the growing emissions of carbon and other dangerous gases. Until these problems are addressed, the oil in the tar sands is best left underground.

Thank you, Mr. Chairman.

Mr. WHITFIELD. The gentleman's time is expired.

At this time, I would like to introduce the witnesses testifying this morning. We appreciate all of you being here. We look forward to your expertise and we anticipate we will learn a lot from your testimony.

First, we have with us Dr. Eddy Isaacs, CEO, Alberta Innovates-Energy and Environment Solutions. We have Mr. Anton Dammer, Former Director, Naval Oil Shale Reserves, U.S. Department of Energy. We have Dr. John Nenniger, who is President and CEO of N–Solv Corporation. We have Mr. William McCaffrey, President and CEO of MEG Energy Company. We have Mr. Murray D. Smith, who is President of Murray Smith and Associates. We have Mr. Simon Dyer, who is the Policy Director for The Pembina Institute. And then we have Ms. Melina Laboucan-Massimo—I should pat myself on the back—for Climate & Energy Campaigner, Greenpeace Canada.

So welcome to all of you. I am going to call on each one of you to give a 5-minute opening statement. And on the front of the desk there there is a little instrument that will have different colors on it. It will have green, yellow, and red, and when it gets to red, that means your time is up. So if you wouldn't mind looking at that periodically. But each of you will be given 5 minutes. And Dr. Isaacs, we will begin with you. So you are recognized for a 5-minute opening statement.

**STATEMENTS OF EDDY ISAACS, CHIEF EXECUTIVE OFFICER, ALBERTA INNOVATES–ENERGY AND ENVIRONMENT SOLUTIONS; ANTON R. DAMMER, FORMER DIRECTOR, NAVAL OIL SHALE RESERVES, DEPARTMENT OF ENERGY; JOHN NENNIGER, CHIEF EXECUTIVE OFFICER, N–SOLV CORPORATION; WILLIAM MCCAFFREY, PRESIDENT AND CHIEF EXECUTIVE OFFICER, MEG ENERGY CORPORATION; MURRAY D. SMITH, PRESIDENT, MURRAY SMITH AND ASSOCIATES; SIMON DYER, POLICY DIRECTOR, THE PEMBINA INSTITUTE; AND MELINA LABOUCAN–MASSIMO, CLIMATE AND ENERGY CAMPAIGNER, GREENPEACE CANADA**

**STATEMENT OF EDDY ISAACS**

Mr. ISAACS. Thank you very much, Mr. Chairman. And thank you for the opportunity to address you. I hope that I can add value to the work of this committee.

I have submitted a short briefing to the committee on what I wanted to address so I will keep my remarks fairly brief. I want to introduce my organization, I want to speak to oil sands technology and the importance of innovation and collaboration, and finally, how this all ties to energy security.

First, my organization, Alberta Innovates—Energy and Environment Solutions, we are one of four new provincial corporations launched by the Alberta Government in January 2010. We serve as the technology arm of the Alberta Government in Energy and Environment. We are a successor to two previous organizations stretching over 37 years. These organizations have been instrumental in creating the climate for commercial development of the oil sands.

We invest or fund research and technology with industry, other governments, and international collaborators. U.S. organizations

are major collaborators not only in oil sands but also in cleaner coal development, in carbon capture, and renewable energy.

I want to switch now to talk about oil sands technology and the importance of innovation. Heavy oil and bitumen are found in many places worldwide. Alberta has the largest global reserves of these hydrocarbons that are not under the control of the state. Technology has been critical to the development of the oil sands resources. Many of the technologies we use today originated by companies operating on both sides of our border. The message for extraction—I think it has been mentioned—are generally mining and in situ. For in situ, we use in situ for the deeper deposits.

The major innovation in mining has been the development in the past 10 years of hydro-transport. Instead of using a truck and shovel, the ore is transported by a pipeline from the mine face as a slurry with water. The oil separates in transit to the plant. This method is operated at lower temperature than conventional extraction, thus reducing energy intensity and greenhouse gases. With in situ methods, our steam-based processes, cyclic steam stimulation, similar technology to what has been pioneered in California in the 1960s; steam-assisted gravity drainage, which has been only in commercial operation for the past 10 years.

New technologies are emerging that are poised to significantly reduce energy intensity, reduce water use and greenhouse gases. These include steam-solvent hybrid processes that are being applied at least by one company commercially today. Use of solvents without steam, you will be hearing about that from Dr. Nenniger and N–Solv is a good example of this type of technology. Electric heating and electromagnetic heating technology is coming into use. Electromagnetic uses radio frequency to heat the oil in the oil sands. These are early days for the electromagnetic heating technology which really does bring the knowhow of the Harris Corporation in radio communication technology with the reservoir expertise of oil sands producers and is a great example of cross-border collaborative effort on a new, innovative, next-generation technology.

I also want to mention carbon capture and storage and the several-billion-dollar investments that are being made in four commercial-sized demonstration projects in Alberta. In addition to new, transformative technologies there is a critical need to focus on emerging innovations to decrease the impact of current technologies on the environment, a good example of the technology deployment action plan for an end-to-end solution for oil sand dealings. This project has brought together all of the oil sands mining companies, the Federal and provincial government, as well as the key engineering technology providers working in the area. Not only are there 100 technologies being evaluate to chart promising pathways, but there is a complete and open knowledge-sharing of pilots and demonstrations that have taken place and practices that have taken place for the past 20 years.

We have had a great deal of success in Alberta from a strong government-industry partnership based on clear business case and well articulated implementation strategies. This is all the formula for success, especially on the environmental front.

In the resource sector, it takes 20 to 30 years to bring new technology to market, much longer than in other sectors, and this in-

creases the risk profile and the financial commitments required. The role of my organization is to work with industry to significantly reduce the time lag for innovation and the risk of adapting new technology, especially next-generation technology.

And the final point I want to make is about energy security. Canada and the U.S. are the only developed countries that can dramatically increase oil production. The chairman alluded to the fact that not only do we have oil from oil sands but also increasingly from shale oil reservoirs, the Bakken type found in North Dakota, Montana, Texas, California, and the Canadian provinces of Manitoba, Saskatchewan, and Alberta. Societal expectations are that in considering economic development, we do what is best for the environment. If we are to be successful on the environmental front, then technology will be the key. To put it in the form of a simple equation, energy security equals energy, economy, environment, and societal values. In all of these, technology innovation is the glue and government's role is to create the conditions that ensure that energy is available, accessible, acceptable and affordable, or in other words, secure.

Thank you.

[The prepared statement of Mr. Isaacs follows:]

Alberta Innovates
Energy and Environment Solutions

**WRITTEN STATEMENT**

**Submission to the Subcommittee on Energy and Power**

**Hearing titled "The American Energy Initiative"**

**For the March 20, 2012 Hearing on**

# The Future of Energy Technology with an Emphasis on Canadian Oil Sands

**Eddy Isaacs, Ph.D.**
**Chief Executive Officer**
**Alberta Innovates – Energy and Environment Solutions**
**Eddy.Isaacs@albertainnovates.ca**

## Summary of Major Points


- The global endowment of heavy oil and bitumen is vast and easy to produce conventional sources are declining. The majority of oil producing countries having reached their peak of oil production. Globally, reserves are being replaced by the more difficult to produce resources such as deep offshore, highly waterflooded reservoirs, tight oil and heavy crudes.
- Heavy oil and bituminous resources, bring a unique set of environmental and social challenges: they are hard to extract and sensitive to market and input costs; the sophisticated technologies used to produce these crudes require a skilled labor force; and careful management of environmental issues especially land disturbance, high water use and greenhouse gas emissions is essential.
- Innovation and technology development have been key to reducing costs of commercial deployment of oil sands and in making **"technology oil"**[1] competitive against


[1] We have coined the term "technology oil" to describe the products derived from oil sands because technology development has been the key to allow bitumen to be produced at competitive costs.

conventional crudes in world markets. Current oil sand production of about 1.7 million barrels per day is a direct result of sustained investments in technological innovation and decades of "learning by doing."

- An increasing focus is now devoted to addressing environmental performance - land reclamation, water recycle and reuse, air emissions, increasing the efficiency of operations, reducing the energy intensity of existing processes, carbon capture and storage and switching to next generation technologies.
- Examples of progress made on environmental issues include:
    - Reduced energy demand in many operations, which is resulting in greenhouse gas emissions of bitumen that are approaching those of US domestic and imported crudes; and,
    - Reduced water consumption with high water recycle rates (>90%) being routinely achieved.
- The Alberta government strategies guide the sustainable development of the oil sand resources with innovation and technology as a strategic driver.
- As a provincial government corporation, the mandate of Alberta Innovates – Energy and Environment Solutions (AI-EES) is to reach sustainable goals in delivering the best available energy and environmental solutions to ensure Alberta remains competitive in a low carbon clean energy and clean water economy.
- AI-EES' balanced portfolio focuses on the key technical, environmental and economic challenges with significant advancements being made through industry-government collaboration and work with international partners.

## The U.S. and Canada: A History of Innovation without Borders

The technology used to produce the bitumen from surface mined oil sands was already well understood when J. Howard Pew, the American industrialist and co-founder of Sun Oil Company (Sunoco), drove the development of the first commercial oil sands project. At the

opening ceremonies for the oil sands plant in 1967, Pew told his audience, "No nation can be secure in this atomic age unless it is amply supplied with petroleum... It is the considered opinion of our group that if the North American continent is to produce the oil to meet its requirements in the years ahead, oil from the Athabasca area must of necessity play an important role."[2] The first years of commercial operations involved overcoming large technological challenges, especially in equipment reliability and process efficiency. But the company persisted despite the hardships and initial failures. Today, Suncor Energy, the successor to the Sun Oil's oil sands venture, is the largest oil sands producer – currently producing some 300,000 barrels/ day from surface mining and *in situ* operations. Suncor is also the leading Canadian producer of renewable fuels such as ethanol and biodiesel.

**Cyclic steam stimulation** technology to develop *in situ* production in the Cold Lake oil sands region was adapted in the 1980's and 1990's from California's heavy oil production expertise. Today Imperial Oil Ltd. (70% owned by US based ExxonMobil) is one of the largest *in situ* oil sands producers using cyclic steam stimulation. Imperial Oil is also a major partner in Syncrude, the second largest producer of synthetic crude from the oil sands.

The drilling of **horizontal wells** was perfected in Canada and today is used to produce oil in the US and in many operations around the world. On the US side, hydraulic fracturing technology, the ability to initiate multiple fractures from horizontal wells, has provided tremendous advances in our ability to develop natural gas and oil from lower-permeability resources. This technology is responsible for more than a 30% increase in conventional oil production in Alberta in the past year alone.

Considering the potential for oil sands production, production from tight shale oil, unconventional gas and inclusion of Mexico's petroleum endowment, North American energy self-sufficiency is no longer just a theoretical possibility.

[2] Peter McKenzie-Brown, Gordon Jaremko and David Finch, "The great oil age: the petroleum industry in Canada" (1993)

Alberta Innovates Energy and Environment Solutions

## AI-EES -- Continuing the Collaboration on Innovation

AI-EES was formed as a Provincial Corporation January 1, 2010. AI-EES builds on the successes of the former Alberta Energy Research Institute (operated between 2000 and 2009) and the Alberta Oil Sands Technology and Research Authority (operated between 1975 and 1999). In 2011, the Alberta Water Research Institute was incorporated into AI-EES' operations. Today, AI-EES serves as the research, innovation and technology implementation arm for the Government of Alberta in energy and environment, applying world-class research and innovation management strategies to preserve and enhance Alberta's economic, environmental and social well-being. AI-EES also serves as the technical arm of the Climate Change and Emissions Management Corporation (CCEMC)[3] in providing strategic advice, technology adjudication and project management.

Alberta has a history of great success in achieving 'breakthroughs' in energy research and technology. In all cases these have come about from **strong government/industry partnerships**, based on clear business cases and with well-developed and articulated implementation strategies. The development of Steam Assisted Gravity Drainage that, in the past ten years, has become the leading commercial technology for producing bitumen from the oil sands, serves as an important example of a technology breakthrough based on government-industry collaboration.

In close collaboration with US organizations, AI-EES is working to develop next generation technologies in several areas of oil sands production, upgrading and carbon capture including:

- Harris Corporation - a pilot project to evaluate electromagnetic heating with and without solvent injection to produce oil with a potential for an over 50% reduction in

[3] The Climate Change & Emissions Management Corporation is a not-for-profit, independent organization with the mandate to achieve actual and sustainable reductions in greenhouse gas emissions and to assist in adapting to climate change. It is funded through carbon penalties from large emitters.

greenhouse gas emissions. The project involves three oil sand producers and the CCEMC.

- Honeywell UOP - development of a slurry phase upgrading technology based on a process developed by Natural Resources Canada that provides a 25% higher liquid yield than the conventional coking process. The project has involved Statoil Canada, and since November 2011, is available for licensing from Honeywell UOP.
- Pratt & Whitney Rocketdyne - pilot testing of Alberta coal and petroleum coke (a by-product from oil sand upgrading) on a novel compact gasifier, leading to reduced equipment costs, increased fuel production and potential for lower cost carbon capture.
- Air Products - pressure swing absorption technology to purify hydrogen and capture $CO_2$ from a sour gas stream, replacing the need for solvents in carbon capture from a gasification process.
- Initiating work with the Pacific Northwest National Lab on a study to be jointly conducted with the University of Ottawa on $CO_2$ capture from flue gas in a micro-structured bed.

In addition to new and transformative technologies needed to ensure long-term sustainable development of the oil sands resources, there is a critical need to focus on emerging innovations to decrease the impact of current technologies on the environment. Examples of environmentally focused projects that showcase collaboration between oil sands producers, academia, AI-EES and other Government of Alberta and Canadian ministries include:

- A technology deployment roadmap and action plan for "end-to-end" solutions for oil sands tailings. With about 100 technologies being evaluated, the study is identifying near term deployment technologies as well promising pathways and gaps for future deployment. The project is significant in achieving knowledge sharing and deployment practices in managing oil sands tailings.
- A study evaluating new and emerging water treating processes to conserve fresh water in oil sands operations. The study involves assessing the impact of increasing thermal *in*

*situ* water recycle and moving toward zero liquid discharge on energy usage, greenhouse gas emissions and waste generation.

- A study to evaluate and understand the effectiveness of silvicultural treatments to speed forest recovery from industrial disturbances caused by, for example, seismic lines in oil sands exploration. This will also involve developing decision-support tools to predict the expected recovery rates of corridors and specifying recommended management actions for each corridor based on restoration needs.
- A study of terrestrial and wetland reclamation of dried fine tailings designed to understand the landform, hydrology and soil placement requirements to support boreal forest ecosystem development.
- A study on nutrient retention requirements in reconstructed soils for reclamation of oil sands mining effected areas. The project is quantifying the nutrient levels in soils in comparison with natural analogs and investigating the impact of fertilization on plant root development to improve landscape design.

## Innovation and Energy Security

Canada and the US are the only developed countries that can dramatically increase oil production – not only from oil sands but from tight shale oil reservoirs (Bakken type) found in North Dakota, Montana, Texas, California and the Canadian provinces of Manitoba, Saskatchewan and Alberta. Energy security for North America, however, implies that energy development and economic competitiveness cannot be separated from environmental protection and social responsibility. To put it in the form of a simple equation:

***Energy Security = Energy + Economy + Environment + Societal Values***

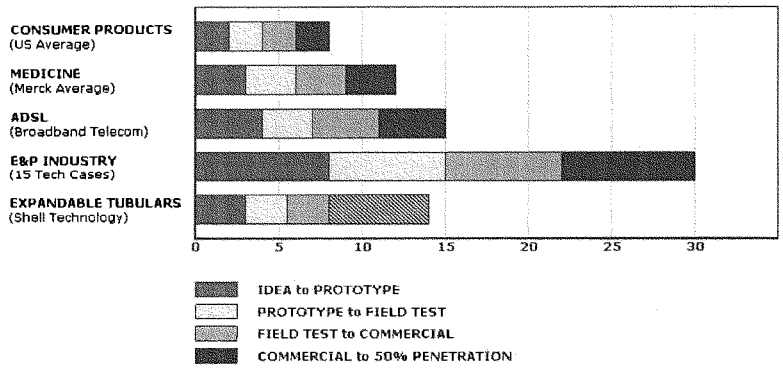
North American energy resources are vast; our economies are heavily dependent on a competitive energy supply; our industry's environmental performance provides the social

Alberta Innovates Energy and Environment Solutions

license to operate and grow; and societal values determine the cleanliness of our energy system. Technology and innovation is the glue to ensure that energy is "available", "accessible" "acceptable" and "affordable" or in other words "secure". Technology development, however, is costly and needs a long lead time to develop, adapt, and implement. Sustained long term investments are, therefore, required for research and innovation.

It takes 20 to 30 years to take an idea from the lab to commercialization (see attached Graph). AI-EES' raison d'être is to significantly reduce the time lag for innovation. The organizations' role is to work with industry to reduce the risk of adapting technology, so investments need to be focused and sustained over long periods due to the length of time it takes to bring new technology to market. In the end it is technology that got us here and technology that is the key to achieving environmental targets, "changing the game" and taking us into a more sustainable future.

Figure on time-to-market in years for various industries showing the comparatively longer period for technology commercialization in the oil and gas industry[4].




[4] Graph developed for Shell by McKinsey, provided courtesy of Petroleum Technology Alliance of Canada (PTAC)

Mr. WHITFIELD. Mr. Dammer, you are recognized for 5 minutes.

**STATEMENT OF ANTON R. DAMMER**

Mr. DAMMER. Thank you, Mr. Chairman and members of the committee. It is a great pleasure and honor to me to share the podium today with Murray Smith from Canada. I think I am the only U.S. citizen on the committee today. Murray was a leader in the orderly and progressive development of the Canadian oil sands.

Development has enabled Canada to be energy-independent, the goal that has eluded our country since the 1960s. Today, Canada is our largest source of imported oil. Canada—Alberta—has increased their proved reserves of oil to 176 billion barrels, second only in size to Saudi Arabia. In comparison, the United States has approximately 22 billion barrels of proved reserves. We can learn from the development of the Alberta oil sands development.

The first and perhaps the most important lesson might be to create a permanent program and decision-making process that promotes research, technology development, regulatory and statutory reform, and public education. Oil sands and oil shale share some distinct physical and developmental characteristics as both resources are unconventional and both resources are well defined, airily consolidated, and highly concentrated.

We also share a common beginning. Following the Arab Oil Embargo, there was a resurgence in interest and purpose in energy independence in both Canada and the U.S. in 1974. In 1974, the DUI prototype Oil Shale Leasing Program awarded two leases in Colorado and two in Utah, attracting $681 million in bonus payment. It seemed that as soon as development gained momentum, it came to an end in 1982 with the precipitous drop in oil prices and the realization that prices would not escalate as originally speculated. Exxon's Colony Project abruptly closed doors without warning, an event that is popularly referred to as Black Sunday.

Not until 25 years later, the passage of EPAct '05 did the U.S. Government demonstrate any appreciable interest in U.S. oil shale resource. In the Energy Policy Act of 2005, the President and the Congress of the United States declared that unconventional fuels, including oil shale "are strategically important resources that should be developed to reduce the growing dependence of the United States on politically and economically unstable sources of foreign oil."

Section 369(h) of that Act directed the Secretary of Energy, in cooperation with the Secretaries of the Interior and Defense to establish a taskforce to develop a plan to accelerate the commercial development of strategic unconventional fuels and initiate partnerships with Alberta and nations with oil shale resources. The taskforce report with recommendations was completed and forwarded to the President in February of 2007. Unlike the Alberta experience, the report was never implemented, no plan, no policy, no progress.

We are grateful for a strong and reliable trading partner to our north, but we are still dependent on the import of close to half of our daily oil requirements. We still consume roughly a quarter of the world's oil supply and we remain reliant on an increasingly

competitive, unstable, and often hostile world oil market for our energy security.

The United States is the custodian of the largest and most concentrated hydrocarbon resource on earth, oil shale. Conservatively estimated to exceed two trillion barrels, it has the potential to provide millions of barrels of production per day if developed in a planned and prudent manner analogous to the Alberta experience. In the Green River Basin of Colorado alone, the USGS estimates that 800 million barrels could be produced, over three times the total reserves of Saudi Arabia.

In spite of lack of national direction in oil shale development, there remains considerable activity in the private sector. The activities of 32 companies are summarized in the report Secure Fuels from Domestic Resources, which is found on the web.

Great progress has been made in limiting water utilization, increasing energy return on investment, and minimizing the environmental impacts historically associated with oil shale development. As history as proved, the only limitation to developing oil shale resource in the United States has been, firstly, economic; and secondly, access to the resource, 80 percent of which is on Federal land. As oil prices range above $100 per barrel, the economics look increasingly attractive and the technical evolution of both surface and in situ technologies are encouraging.

The oil shale moratorium established under the Hoover administration in 1930 remains in effect. Today, a handful of oil shale R&D leases have been parsed out by the Department of Interior. Another programmatic environmental impact statement has been published and is now in comment, a weak, disjointed, and affected process, unable to provide industry the surety of commitment on the part of the government to risk investment of billions. We need to plan for the development of this prolific U.S. resource as the Canadians plan for the successful development of the Athabasca oil sands. We have the mechanism through Section 369 of EPAct '05. Ironically, failure to perform the requisite planning and preparedness will inevitably lead us back to everyone's deepest fear—Black Sunday.

Mr. Chairman and members of the committee, I thank you once again, and I look forward to working with you in any capacity in furtherance of national security and preparedness.

[The prepared statement of Mr. Dammer follows:]

**Written Testimony**

**Anton (Tony) R. Dammer**

**Independent Energy Consultant on Unconventional Fuels**

**Senior Vice President - Red Leaf Resources, Inc. (Retired)**

**Director Naval Petroleum and Oil Shale Reserves, U.S. DOE (Retired)**

**Before the**

**House Energy and Commerce Committee**

**Subcommittee on Energy and Power**

**March 20, 2012**

## Introduction

Mr. Chairman and members of the Committee, I am Tony Dammer, recently retired from Red Leaf Resources, Inc., a small and successful oil shale technology and resource development company located in Utah. Previously I served as the Director of the Naval Petroleum and Oil Shale Reserves within the Department of Energy. The office was responsible for the implementation and management of Sections 369 (h) and (i) of the Energy Policy Act of 2005 and produced all of the studies and analyses found at www.unconventionalfuels.org.

I thank you for the opportunity to appear to today. It is a great pleasure and honor for me to share the podium with the Honorable Murray Smith. Murray was leader in the orderly and progressive development of the Canadian oil sands in Alberta. That development has been a tremendous success, attracting most, if not all, of the major oil companies in the world to participate in its development; bringing massive capital, both financial and intellectual, to Alberta. The result of this development has created immeasurable wealth and prosperity for Canada, Alberta, and the general populous of the region.

Further – development has enabled Canada to be energy independent, a valued goal that has been advocated by every President since Nixon, but has eluded our country since the 1960's.

Today, Canada is our largest source of imported oil. In a world where the much of the oil is produced in countries that are volatile and in many cases antagonistic to the interests of the United States, Canadian oil imports represent a significant national security benefit to our Nation.

Canada (Alberta) has increased their proved reserves of oil to 176 billion barrels, second only in size to Saudi Arabia. In comparison, the United States has approximately 22 billion barrels of proved reserves. Proved reserves are, in a very real sense, the definition of energy independence. Insurance, so to speak, that mitigates being held hostage to imported oil. I will discuss the massive oil shale resource in this country later in my talk.

We Can Learn from the Development of the Alberta Oil Sands. The first and perhaps the most important lesson might be; to create a permanent program and decision-making process that promotes research, technology development, regulatory and statutory reform, and public education. The Province of Alberta did not discontinue its oil sands development plan because of economic pressures, i.e. low oil prices in the 1980's, as we did in the United States. They had established joint government/industry institutions and NGOs that sustained interest and development in their resource and promoted cooperative technology development and systematic public education concerning the environment, economy and aboriginal issues. Organizations like the National Task Force on Oil Sands Strategies, Alberta Oil Sands Technology and Research Authority (AOSTRA), Canadian Oil Sands Network for R&D (CONRAD), Alberta Research Center (ARC), National Center for Upgrading Technology (NCUT), to name a few that and all worked with the fundamental goal to develop Alberta's resource in a sustainable

manner and in conformance with the wishes of their citizens. They had a vision and they elaborated that vision though the establishment of cohesive partnerships and institutional planning. It should be emphasized that over the decades that Alberta has been engaged in these processes – they have progressed their science and engineering capabilities; resolved many of their environmental problems; and have become more operationally efficient. None of this took place overnight in some manner of gold rush. On the contrary, it assured and sustained a reasoned and deliberate course of development.

United States had no similar organization and as history attests we abandoned oil shale development in the early 1980's with the decline of oil prices at the time. Had we the organizational framework to stay the course and develop our oil shale resource in a manner similar to Alberta we would likely have an industry today.

Oil Sands and oil shale have some distinct physical and developmental characteristic in terms of the resource itself that are worth emphasizing, as both resources are well defined, consolidated, and concentrated:

1. *No exploration risks* – The richness, characteristics, and magnitude of the oil shale resources are known. Without exploration uncertainty, investment decisions can be based on technology, regulatory and market considerations, all of which can be controlled through sound program planning and development. As with conventional oil there are no dry-hole risks.

2. *Long-term production assurance* – Large resource bases allow for production planning for decades. Oil shale production does not experience the decline curve seen in conventional oil.

3. *Uniform product quality* – Since oil shale is the product of a manufacturing process the product quality can be controlled and is uniform and reliable. As much of the worlds light and sweet crude oil has been produced, today's conventional oil is increasingly variable with higher levels of sulfur and lower API gravity.

4. *Stable operating costs* - Oil shale unit operating costs will remain reasonably steady because they will not increase commensurately with production decline and the requirement to employ secondary recovery methods.

5. *High front-end capital investments are off-set by the certainty ond longevity of production* - As we have seen repeatedly in Alberta, once the industry is in the operations phase, even escalating capital costs are offset by the consistency of the (manufacturing) production process.

Although the physical and developmental attributes of these two unconventional resources are quite similar, history approached their respective developments quite differently. While Alberta stayed the course after the collapse of oil prices in the early 1980's the United States had no sustainable programs or policies to support continued progress in research and development.

Following the Arab Oil Embargo there was a resurgence of interest and purpose in energy independence. In 1974, Prototype Oil Shale Leases were awarded by the government: two in Colorado (Ca and Cb) and two in Utah (Ua and Ub). Two other leases were offered in Wyoming but received no bids. These leases were limited in size to 5120 acres, which was the statutory limitation on acreage under the Mineral Leasing Act of 1920. None-the-less, the Colorado and Utah sites attracted $641 million in bonus payments. The bonus bid money, incidentally was directed to the States for infrastructure development and mitigation of socio-economic

impacts. At the same time, the Exxon Colony project and the Unocal Parachute Creek projects began to develop aggressively on fee lands. These companies spent billions of dollars in the Piceance Basin area of Colorado. My old office, the Naval Petroleum and Oil Shale Reserves, worked steadily on the oil shale development plan for their reserves outside Rifle, Colorado. In 1980 the Synthetic Fuels Corporation was established and allocated tens of billions of dollars for the development of domestic sources of energy. It was in every respect an oil shale boom.

And it seemed that as soon as development gained momentum it came to an end in 1982 with the precipitous drop in oil prices and the realization that prices would not escalate as originally speculated. Colony abruptly closed its doors without warning in an event that is popularly referred to as Black Sunday. The event continues to evoke strong emotions to this day as it resulted in loss of thousands of jobs and precipitous decline in property values. It remains a rallying cry for the opposition to oil shale development in the region to this day.

Other large enterprises eventually followed Colony. Unocal continued operation for several years as did Occidental Petroleum on one of the Federal leases, but they too eventually discontinued operations. The DOE Anvil Points R&D facility was closed and reclaimed and the Naval Oil Shale Pre-Development Program suspended. The Synthetic Fuels Corporation was essentially defunded and eventually drifted out of business after closing out its few obligations.

Unlike Alberta oil sands development, the United States abandoned oil shale and the technical advancements gained during the 1970's and before.

Not until over twenty-five years later and the passage of the EPACT 05 did the U.S. Government demonstrate any appreciable interest in the U.S. oil shale resource. Once again, growing

concerns regarding energy geopolitics and dependence on oil imports from unfriendly or unstable sources became an issue of National concern. The Energy Policy Act of 2005 was a comprehensive piece of legislation designed to address a broad variety energy issues.

In the Energy Policy Act of 2005 the President and the Congress of the United States declared that unconventional fuels, including oil shale, ***"are strategically important resources that should be developed to reduce the growing dependence of the United States on politically and economically unstable sources of foreign oil imports".*** Section 369 (h) of the Act directed the Secretary of Energy, in cooperation with the Secretary of the Interior and the Secretary of Defense ***"to establish a Task Force to develop a plan to accelerate the commercial development of strategic unconventional fuels and initiate partnerships with Alberta and nations with oil shale resources."*** The Task Force report, with recommendations, was completed and forwarded to the President and Congress in February 2007. It can be found at www.unconventionalfuels.org. The effort was a laborious and successful undertaking, involving three cabinet-level offices, five State Governors, and three community representatives. Unlike the Alberta National Task Force on Oil Sands Strategies, however, that report now gathers dust on numerous bureaucratic bookcases around Washington. No plan – no policy – no progress as in Alberta. We are essentially looking down the same barrel of the gun we looked down in 1974. It might even be worse as the entire Arab lateral appears in turmoil.

In conclusion, the United States is in no better shape with regard to oil independence then we were at the time that EPACT 05 passed and worse than at the time of the Arab Oil Embargo of the 70's. We are grateful for a strong and reliable trading partner to our North but we are still dependent on the import of close to half our daily oil requirements. We still consume roughly a

quarter of the world's oil supply and we remain reliant on an increasingly unstable and often hostile world oil market for our energy security.

The United States is the custodian of the largest and most concentrated hydrocarbon resource on earth – oil shale. Conservatively estimated to exceed 2 trillion barrels it has the potential to provide millions of barrels of indigenous production per day if development is planned prudently in a manner analogous to the Alberta experience. In the Green River Basin of Colorado alone the USGS estimates that 800 million barrels could be produced – over three times the total reserves of Saudi Arabia.

In spite of the lack of national direction in oil shale development there remains considerable activity in the private sector. The activities of thirty-two companies are summarized in the Secure Fuels from Domestic Resource report found at www.unconventionalfuels.org. Although none are in the commercial stage of production, many have demonstrated great promise and, in some cases, the technical viability of their process. Great progress has been made in limiting water utilization, increasing energy return of investment, and minimizing the environmental impacts historically associated with oil shale development. Established oil shale technologies developed in Estonia, Russia, China, and Brazil have been active for decades. As history has proved the only limitation to developing the oil shale resource in the United States has been: Firstly – economic; and secondly access to the resource, eighty percent of which is on Federal land. As oil prices range above $100 per barrel the economics look increasingly attractive and the technical evolution of both surface and in-situ technologies encouraging.

The oil shale moratorium established under the Hoover administration in 1930 remains in effect. Today a handful of oil shale R&D leases have been parsed out by the Department of the

Interior. Another Programmatic Environmental Impact Statement has been published and is now in the comment stage. While these are for the most part good steps forward, one must wonder how many times we need to see this movie before we move forward.

We need to plan for the development of this prolific U.S. resource, as the Canadians planned for the successful development of the Athabasca oil sands. We have the mechanism through Section 369 of EPACT 05. Ironically, failure to perform the requisite planning and preparedness will inevitably lead us back to everyone's deepest fear...."Black Sunday".

Mr. Chairman and members of the Committee - thank you once again and I look forward to working with you in any capacity in furtherance of national energy security and preparedness.

I would be pleased to answer any questions.

I have submitted for the record: **Energy: Life Blood of Our Society** a short video on oil shale prepared by the National Oil Shale Association and a White Paper **Economic Impact of Failure to Implement Legislative Mandates of Sec 369, Energy Policy Act 2005,** by Anton Dammer and Dr. James Bunger.

# ECONOMIC IMPACT OF FAILURE TO IMPLEMENT LEGISLATIVE MANDATES OF SEC 369, ENERGY POLICY ACT 2005

A WHITE PAPER

BY

ANTON DAMMER, M.S.

AND

JAMES BUNGER, PH.D.

MARCH 15, 2011

OUR NEED FOR DOMESTIC ENERGY IS INCREASING, NOT DECREASING

It is abundantly clear that US economy depends on affordable and available supplies of energy. While recent attention is being paid to prices, the long-term outlook places doubt on adequate supply. It is easy to see that the greater our domestic supply, and the more imported oil that is produced in the Western Hemisphere, the more secure will be our Nation and Economy.

Congress recognized these facts when they passed the Energy Policy Act of 2005 (Act). In particular, Sec 369 of that Act focused directly on promoting the development of liquid fuels from the Nation's vast unconventional hydrocarbon resources. In particular, the law provided for the leasing of federal oil shale lands and the study and mitigation of technical, economic and regulatory impediments to unconventional fuels development.

Immediately following passage of the Act, the Departments of Energy and Interior, assisted by the Department of Defense set about to pursue the mandates of Sec. 369. Tangible progress had been made in the prior Administration and this progress is outline in the Appendix at the end of this paper. However, further progress toward the goals of Sec 369 have not only languished, but in certain instances have been obstructed by the current Administration.

Given the increasing need for domestic energy, and the long lead times needed to produce such resources, what are the potential impacts of obstruction and delays in development of these resources?

DEVELOPMENT OF RECOMMENDATIONS

Following passage of the Act an Unconventional Fuels Task Force was formed comprised of cognizant federal agencies (Energy, Interior and Defense), States that contained resources (Colorado, Utah, Wyoming, Kentucky and Mississippi), and local officials from potential producing areas.

The Task Force was staffed by the Office of Petroleum Reserves, Office of Naval Petroleum and Oil Shale Reserves (NPOSR) who were charged with the responsibility of executing the mandates of Sections 369 (h) and (i). As of the end of 2008 NPOSR had completed all requirements save the "implementation" part of the program. That path to implementation is clearly defined in both the subject Task Force Report and the Strategic Plan: Unconventional Fuels Development within the Western Energy Corridor, both found at **www.unconventionalfuels.org.**

Simultaneously, the US Dept of Interior pursued their mandate to promulgate leasing regulations for oil shale. Part of this effort also involved the preparation of a Programmatic Environmental Impact Statement (PEIS), the updating of Resource Management Plans (RMPs) in the oil shale resource areas, and the offering and issuance of technology Research,

Development and Demonstration (RD&D) leases. By the end of 2008, the Dept. of Interior had completed the PEIS, had awarded 6 RD&D leases and on Nov 18, 2008 issued final leasing regulations.

The Unconventional Fuels Task Force prepared a schedule for development and itemized in some detail the impediments to that development. Many of these impediments have their origins in policy and legislation controlled by the Federal Government. The greatest limitation to expeditious oil shale development is the uncertainty over access to resource and understanding of Federal regulations governing Federal lands. Had these impediments been mitigated, and leasing proceeded as mandated in Sec 369, the US would be well on its way to substantial production of oil from these vast, secure domestic resources.

Instead, not only has the current Administration failed to implement the Task Force action items, but has actually withdrawn leasing, which would have engaged the private sector in advancing development. Additionally, they have allowed the regulatory process to remain in a state of confusion. In particular, they have threatened to reopen the RMPs, and they have threatened to change the terms of the RD and D leases. The Administration (through the Department of Interior) has been complicit in a recent court ruling (Feb 15, 2011) delaying indefinitely the commercial and RD and D lease activities. All of this adds uncertainty to any investment, and causes capital to remain on the sideline.

The question some in Congress are asking, is 'what are the implications of these adverse policies to our Nation's energy supply and economic security?' The adverse impact of this Administrative action can be quantified by comparing the *possible* with the *reality*.

THE ECONOMIC IMPACTS OF FAILURE TO IMPLEMENT RECOMMENDATIONS

As part of the Strategic Unconventional Fuels Program, the Office of Naval Petroleum and Oil Shale Reserves developed an economic model to project potential economic benefits that would accrue from an oil shale industry over a 25 year period, 2009 – 2035. Three different development scenarios were modeled on 2010 $45/bbl and 2035 $65/bbl oil:

1. Base Case: production of 0.5 million barrels per day by 2035 had no Government incentives other than a $40/bbl floor and was based on development of three major insitu production companies.

2. Moderate Case: Production of 1.5 million barrels per day by 2035 had a $40/bbl price floor and a $5/bbl production tax credit and was based on six insitu projects and one surface retorting operation.

3. Accelerated Case: Production of 2.4 million barrels per day by 2035 with a price floor of $40/bbl, $5/bbl tax credit, and cost shared demonstration facilities for three technologies and was based on a variety of 17 projects.

Each scenario had a pre-production start-up time from between nine years for the Base and Moderate Cases and four years for the Accelerated Case. The clock on these cases was to

have started in 2008. Indeed, the Department of Interior promulgated regulations for leasing on November 18, 2008.

With oil prices currently in the $100/bbl range and 2010 monthly closing prices averaging $79/bbl the economic benefits calculated in the model are modest. There are few experts who foresee an appreciable decline in future oil prices while many predict dramatic increases based upon continuing supply uncertainty and growing demand in developing nations. Technological progress in the private sector has been increasingly aggressive and productive. The cumulative economic benefits of the three cases in the model are:

| *Timeframe = 25 years* | *Base* | *Moderate* | *Accelerated* |
|---|---|---|---|
| Production (Billion Bbls) | 0.8 | 1.4 | 2.2 |
| Federal Revenue | 11 | 15 | 29 |
| State & Local Revenue | 7 | 13 | 23 |
| Public Sector Revenues | 18 | 28 | 52 |
| Growth in GDP | 71 | 146 | 255 |
| Value of Imports Avoided (Billions $) | 52 | 108 | 215 |

To adjust the model numbers to reflect the current situation, the following assumptions are applied:

1. Oil price is increased by a flat 20% (the difference between the monthly closing average in 2010 of $79/bbl and the models 2035 price of $64/bbl). This is obviously very conservative since the difference in the 2035 price in the model and closing price of oil on March 1, 2011 was close to 40%.
2. There is no need for price floors, tax credits, and Federal cost-shared demonstrations.
3. All projects are delayed by half of their economic life, or approximately 12 years.

Under those very simplified assumptions, that do not account for the loss of time value of money nor current oil price escalation, the cost of government inertia is substantial, as below.

| *Timeframe = 25 years* | *Base* | *Moderate* | *Accelerated* |
|---|---|---|---|
| Production (Billion Bbls) | 0.4 | 0.7 | 1.1 |
| Federal Revenue | 6.6 | 9 | 17.5 |
| State & Local Revenue | 4.2 | 7.8 | 13.8 |
| Public Sector Revenues | 10.8 | 16.8 | 31.2 |
| Growth in GDP | 42.6 | 87.6 | 153 |
| Value of Imports Avoided (Billions $) | 31.2 | 64.8 | 129 |

It should also be noted that oil shale development, as with other oil and gas industry developments, are a source of high paying employment. In the negative employment environment we are now experiencing in the United States it is estimated that delay of oil shale development would result in the loss of high-paying direct jobs on the order of 4850, 13,000, and 21,700 for the Base, Moderate, and Accelerated Cases respectively.

Additionally, indirect jobs in the private service sector are several times the number of direct jobs, and these are lost as well.

CONCLUSIONS

What makes oil shale important to United States national security is the nature of the resource itself. It is the largest hydrocarbon resource on earth. On a per acre basis, it is the most concentrated oil bearing resource on earth. Yet as a nation, we continue to avert attention from this valuable resource and consciously impede and deny those actions that are required to develop U.S. domestic resources in a safe and environmentally responsible manner. We continue, as a Government, to foreclose on our own success. This is mysteriously destructive behavior. In the Energy Policy Act of 2005 the President and the Congress of the United States declared that unconventional fuels, including oil shale, ***"are strategically important resources that should be developed to reduce the growing dependence of the United States on politically and economically unstable sources of foreign oil imports".***

Today the implied threat engendered in those words could not be more poignant.
Recent unrest throughout the Arab lateral has driven world oil prices over $100/bbl. In Section 369 of the Act Congress outlines a rational process to begin the requisite planning and analysis to fully understand and eventually develop our domestic oil shale resources. The important work accomplished by DOI has been indefinitely suspended through the settlement of the oil shale leasing regulations suit. The Unconventional Fuels Program within the Office of Petroleum Reserves in the DOE is being de-funded and essentially abandoned. All the extensive preparatory work accomplished by the Task Force and Ad Hoc Working Group is to be ignored and archived, to the detriment of the nation's energy security. It is in the hands of Congress to require that the provisions of the law be executed in a manner that will assure the objectives of the Act are accomplished.

APPENDIX – SUMMARY OF SEC 369 AND MANDATED ACTIVITIES

## SEC. 369. OIL SHALE, TAR SANDS, AND OTHER STRATEGIC UNCONVENTIONAL FUELS.

***Declaration of Policy. – Congress declares that it is the policy of the United States that***

- ***(1) United States oil shale, tar sands, and other unconventional fuels are strategically important resources that should be developed to reduce the growing dependence of the United States on politically and economically unstable sources of foreign oil imports;***
- ***(2) The development of oil shale, tar sands, and other strategic unconventional fuels, for research and commercial development, should be conducted in an environmentally sound manner, using practices that minimize impacts; and***
- ***(3) Development of those strategic unconventional fuels should occur, with an emphasis on sustainability, to benefit the United States while taking into account affected States and communities.***

There followed a number of provisions (Sections) of the Act to assign responsibility and assure implementation of the policy.

**SECTIONS** ***(c) thru (e): Leasing Program for Research &Development; Programmatic Environmental Impact Statement and Commercial Leasing Program for Oil Shale and Tar Sands.-***

The Secretary of the Interior was required to implement an oil shale and tar sands R&D leasing program to include: a Programmatic Environmental Impact Statement within 18 months; final leasing regulations not later than 6 months after the EIS; and begin commercial leasing no later than 180 days after publication of the subject regulations.

***Accomplishments:*** *The PEIS and leasing regs have been completed. No commercial leasing has been offered or begun.*

**SECTION** ***(h): Task Force. -***

The Secretary of Energy, in cooperation with the Secretary of the Interior and the Secretary of Defense was to establish a Task Force to develop a program to coordinate and accelerate the commercial development of strategic unconventional fuels and initiate partnerships with Alberta and nations with oil shale resources. Further, the Task Force was to make such recommendations regarding promoting the development of strategic unconventional fuels resources within the United States as it deemed appropriate. The Act directs that the Task Force provide Congress and the President a report that describes their analysis and recommendations within 180 days. (Section 369(i) of the Act designated the Office of Petroleum Reserves to coordinate and provide staff support to the Task Force.)

*Accomplishments:*

- Task Force established, with representatives of Sec. of Energy, Defense, and Interior: Governors of Colorado, Utah, Wyoming, Kentucky and Mississippi; and three local representatives from potentially effected counties – January 2006.
- Twelve Task Force Meetings and three conference calls held - March 2006 and December 2009.
- Initial Report to Congress: *"Development of America's Strategic Unconventional Fuels Resources"*, forwarded to Congress and the President – September 2006.
- Three Volume comprehensive report, with recommendations, *"America's Strategic Unconventional Fuels"*, forwarded to the President and Congress – February 2007.
- Last Annual Report to Congress – December 2008

**SECTION 369** ***(i): Office of Petroleum Reserves. -***

Directed the Office of Petroleum Reserves to coordinate the creation and implementation of a commercial strategic fuel development program; promote and coordinate actions that facilitate development; and evaluate importance of fuels for the security of the United States. The Act directs the Secretary to submit a report to Congress and the President on activities under this section.

*Accomplishments:*

- Report to Congress and President, *"Activities, Accomplishments, and Plans Related to Section 369 of the Energy Policy Act of 2005"* completed and forwarded to Office of Management and Budget for clearance - January 2006.
- Established an Ad Hoc Unconventional Fuels Working Group, over 30 representatives of public and private interests, convening multiple strategic planning meeting - Jan. 2006 - October 2009.
- Ad Hoc Working Group Strategic Plan - November 2008.
- Comprehensive economics decision model *"National Unconventional Fuels Model"* - December 2005.
- Report profiling companies engaged in domestic oil shale and tar sands resource and technology development *"Secure Fuels from Domestic Resources"*- June 2007.
- Report *"Carbon and Water Resources Impacts from Unconventional Fuels Development in the Western Energy Corridor"* – Los Alamos National Lab Draft Completed June 2010.
- Report *" Oil Shale Research in the United States"*- June 2009

**SECTION 369** ***(l): Cost-sharing Demonstration Technologies.-***

The Secretary of Energy shall identify technologies for the development of oil shale and tar sands ready for demonstration at commercially representative scale. ( Responsibility to Office of the Deputy Assistant Secretary for Oil and Gas Research and Development.)

***Accomplishments:*** *None, due to lack of funding or appropriations.*

**SECTION *(m): National Oil Shale and Tar Sands Assessment.-***

The Secretary of the Interior shall carry out a national assessment of oil shale and tar sands for the purpose of evaluating and mapping oil shale and tar sands deposits in the Green River Basin of Colorado, Utah, and Wyoming, Devonian shales east of the Mississippi; and areas of the central and western U.S. including Alaska, in that order of priority.

***Accomplishments:*** *USGS has completed mapping the Colorado oil shale resource, increasing probable reserves estimates by 500 million barrels. Currently concluding work on Utah Green River Resource.*

**SECTION *(p): Heavy Oil Technology and Economic Assessment.-***

The Secretary of Energy to update 1987 technical and economic assessment of domestic heavy oil resources prepared by the IOGCC, to include all of North America and all unconventional oil, including heavy oil, tar sands (oil sands) and oil shale. (Assigned to the Office of the Deputy Assistant Secretary for Oil and Gas Research and Development.)

***Accomplishments:***

- Report *"A Technical, Economic, and Legal Assessment of North American Oil Shale, Oil Sands, and Heavy Oil Resources"* - September 2007. University of Utah

**Conclusion:** The Task Force concluded that: ***"The Nation is substantially at risk, from an economic and security perspective, to warrant development of an unconventional fuels program with attendant policies and government actions to promote and accelerate industry development".*** There has been misguided criticism regarding what is perceived as a recklessly accelerated pace of development of unconventional resources. Criticism that is founded in a distorted and exaggerated recollection of the history of past attempts to develop these resources and fueled by an almost complete misunderstanding of the objectives of Section 369 and subsequent analyses and plans published by the DOE. The intent of the Unconventional Fuels Program is to design a creative, rational, effective, and measured development roadmap that will mitigate the impacts the critics seem to believe are inevitable. The approach envisioned and designed by the Task Force and the Ad Hoc Unconventional Fuels Working Group is essentially an integrated regional energy development roadmap called the Western Energy Corridor Initiative.

Without such a roadmap; without a clear understanding of the technical, economic, and social impacts associated with developing these resources – solid decision-making based on facts gives way to decisions based on fear, innuendo, and misinformation. A worse scenario

would be to rush development of unconventional resources in response to crisis, in the same manner as the ill-fated and much criticize Colony project in 1982. The reason this is such an important program is to prevent what the critics fear the most.

About the authors

Anton (Tony) Dammer served as Director of the US Office of Naval Petroleum and Oil Shale Reserves (NPOSR) from 1988 until he retired from Government in 2008. During that time he managed the US interests in these important domestic resources, and was the driver to raise the profile on oil shale over the past decade. He can be reached at anton.dammer@gmail.com.

James Bunger has conducted research in unconventional fuels for more than 40 years. He served as technical project consultant for NPOSR, and co-authored the 2004 DOE publication Strategic Significance of America's Oil Shale Resources, credited by some as reinitiating the technical and policy dialog on US oil shale. He can be reached at jwba@jwba.com.

Mr. WHITFIELD. Thank you.
Dr. Nenniger, you are recognized for 5 minutes.

**STATEMENT OF JOHN NENNIGER**

Mr. NENNIGER. Thank you. Good morning, Chairman Whitfield, Ranking Member Rush I guess is not here and members of the committee. I am John Nenniger, CEO of a technology company called N–Solv. I am a Canadian who has had the great privilege of earning a doctorate in chemical engineering from MIT. My energetic and remarkably patient wife is an American citizen, born and raised in Kentucky, who also has a doctorate in chemical engineering.

It is a great honor for me to be here today to discuss solvent-based oil sands extraction. Inexpensive energy is good for the American economy but the evidence of climate change is both compelling and terrifying. This is a profound moral dilemma. I believe that harm reduction is the most pragmatic option. On the oil sands, this means finding profitable ways to produce cleaner oil.

The N–Solv extraction process is an underground extraction process similar to steam except condensing solvent provides the heat. The N–Solv process produces a more valuable product for a lower cost because it is energy efficient and it does not use water. Although our laboratory results are very encouraging, N–Solv has not yet been tested in a reservoir. In comparison to steam, N–Solv is expected to reduce energy consumption by 85 percent, reduce well-to-tank greenhouse gases by 205 pounds per barrel, increase oil value by 23 percent, reduce capital and operating expenses by 30 percent, double the net back per barrel, triple the payout. Our field pilot is expected to produce first oil in April of 2013.

As a scientist, I view extravagant claims with great skepticism unless they can be supported with compelling evidence. I don't have time to present our evidence today but there is more detail in the written handout and on our Web site. We found that bitumen dissolution into solvent proceeds in a way that was quite different than what everybody had thought. Our observations have been independently confirmed by researchers at a number of different universities. Although there has been decades of experimental work on solvent, our results show that the previous interpretation of lab experiments was incorrect, and consequently, the reservoir predictions were also incorrect.

We developed a sophisticated apparatus and ran a series of experiments to measure chamber growth rates. Our experiments showed we could achieve oil rates at 100 degrees Fahrenheit that were three times faster than steam at 450 Fahrenheit. To make sense of our results, we assembled a database of every solvent experiment in the scientific literature. We were able to successfully correlate the literature data over a huge range of conditions and our lab results are exactly in line with the independent data from the literature. This gives us great confidence that our spectacular results are real and credible.

It is the early days for N–Solv, so discussion of its economics are speculative. The commercial advantage comes from producing a more valuable oil at a lower cost. The oil is more valuable because

it is de-asphalted. On the process capital cost is cut in half because there is no boiler feed, water treatment, and no steam generation.

The net back for N–Solv of $52 per barrel is expected to be almost twice as high as SAGD. The payout ratio, $6 of net back per dollar of investment is three times higher than SAGD. Remarkably, we think these numbers are understated. The ability to operate modest temperature and pressure will help us access standard bitumen resource that is currently uneconomic, including the carbonates which contain over 1,000 billion barrels.

Now, I am going to talk about the environmental benefits. N–Solv does not use any water. That is a big deal. N–Solv reduces the energy consumption by 85 percent because the extraction takes place at 100 Fahrenheit instead of 450. The 85 percent reduction doesn't capture the entire story because the oil quality makes it easier to upgrade and refine. We are building a $60 million field pilot to test the N–Solv technology in a reservoir setting. Suncor Energy has offered to host the pilot, including building the wells. Hatch has made major capital investments and is providing the engineering. We have received financial support from Sustainable Development Technology Canada. I can't say enough good things about SDTC. Enbridge Pipelines has also contributed significant capital towards the pilot.

The final item I want to talk about is safety. Safety is always at the top of our minds. The science tells us that we can achieve commercial extraction rates at modest temperatures and pressures. Over-pressuring the reservoir is both unnecessary and economically undesirable. If a high temperature is needed at a lower pressure, the operator can always change to a more appropriate solvent.

In summary, N–Solv produces a more valuable product at a lower cost because it is energy efficient and does not use water. I look forward to your questions and comments. Thank you.

[The prepared statement of Mr. Nenniger follows:]

WRITTEN STATEMENT

FROM

*Dr. John Nenniger, Fellow of Canadian Academy of Engineering;*

*CEO, N-Nolv Corporation*

MARCH 20 2012

n-solv Corporation

My Company, N-Solv Corporation has developed an energy efficient underground oilsands extraction process that does not use any water. Although the laboratory results are very encouraging, oil production process has not yet been tested in an underground reservoir. In comparison to steam, N-Solv is expected to:

- Reduce extraction energy by 85%
- Reduce Well to Tank GHG's by 200 pounds per barrel (93 kg/bbl)
- Increase oil value by 20%
- Reduce capital and operating expenses by 30+%
- Double the netback ($profit per barrel of oil)
- Triple the capital efficiency ($ profit per $ of risk capital)
- Enable access to a portion of the 1,500 billion barrels of stranded (uneconomic) Albertan bitumen reserves
- Our field pilot is expected to produce first oil in April of 2013
- Worldwide there are 3,000 billion barrels of stranded heavy oil and we expect solvent extraction to greatly increase the recovery of this resource.

n-solv Corporation

Good afternoon Chairman Whitfield, Ranking Member Rush, and members of the committee. I am John Nenniger, CEO of the technology company, N-Solv Corp. I am a Canadian citizen who has enjoyed the great privilege of earning a doctorate[1] in Chemical Engineering from MIT. My energetic and supportive wife is an American citizen whom I met while attending MIT and she also earned a doctorate from MIT. My father, who is the co-inventor of our technology, also has a doctorate in chemical engineering. His insights and encouragement, starting with his patent application[2] filed almost 40 years ago, have been enormously helpful.

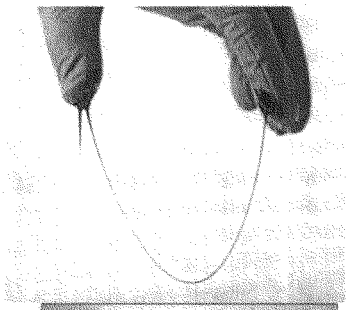
It's a great honour for me to be here today to discuss clean solvent based oilsands extraction technology. Inexpensive energy is good for the American economy but cheap energy can encourage wasteful consumption. The evidence of climate change is compelling and terrifying. This presents a profound moral dilemma. I believe "harm reduction" is the most pragmatic option. This means finding profitable ways to produce cleaner products.

Oil prices are set by surplus or deficit in supply rather than production cost. Consequently, the oil prices are largely set by the elasticity of oil demand. Energy efficiency produces $300/bbl of benefits to US consumers[3] and new oil supply produces $100/bbl of benefits. Either way, American consumers win. However, the big money is from conservation-energy efficiency, which is also good for the planet.

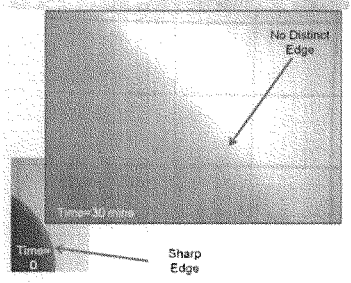
n-solv Corporation

## SCIENCE

The N-Solv oil extraction process is very similar to steam assisted gravity drainage (SAGD) except condensing solvent provides the heat instead of steam. N-Solv promises huge environmental and commercial advantages. It is useful to start with a review of the science of solvent extraction.



Bitumen has many unusual characteristics. The photograph to the left shows a filament of bitumen which is being stretched. For most materials, stretching produces a "neck" and the filament then thins and breaks at this neck. However, the bitumen filament stretches quite uniformly, which demonstrates rubbery behavior. This is due to molecular entanglements within the bitumen.




The two photographs on the left show a drop of dye placed into stagnant water and its progress one half hour later. The dye spreads to a diameter many times larger than the initial drop diameter. The dye spreads into the water and vice versa so the sharp edge gets "smeared" out.

Scientists believed that bitumen dissolution in solvent would resemble this intermingling of water and dye. Consequently, computer models of solvent extraction consistently show the solvent penetrating deeply into bitumen[4]. In the computer prediction shown on the left, the solvent forms a broad smear that extends 30 meters (100 feet) away from the wellbore.

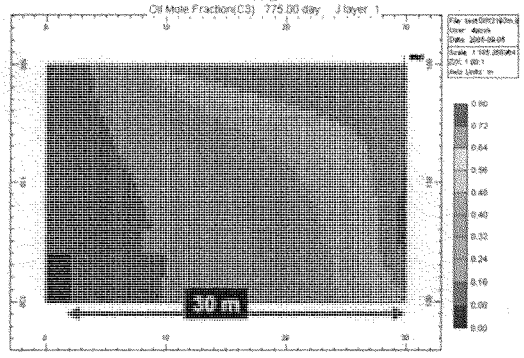
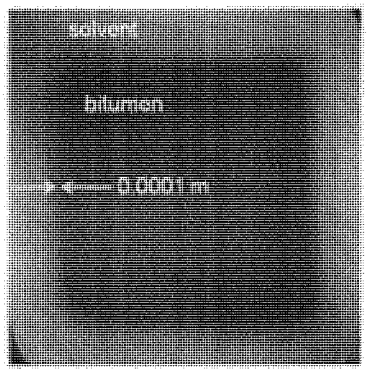



Figure 6. Propane concentration in bitumen at 775 d.

Yet if one carefully looks at how bitumen dissolves in a solvent, the bitumen slowly recedes like a melting ice cube. Instead of seeing a "big smear", there is a very sharp

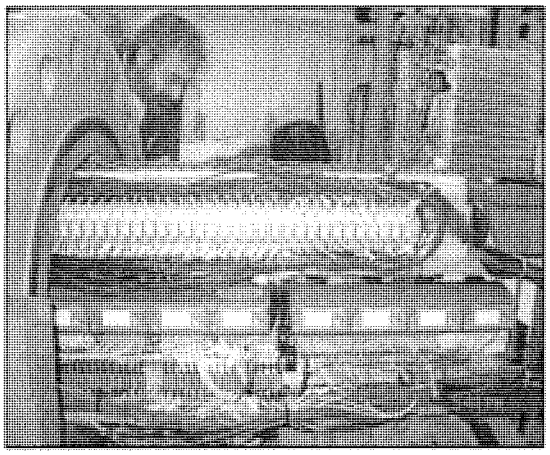
edge between the solvent and the bitumen (yellow arrows). The "smear" is confined to an extremely thin layer about the same thickness as a sheet of paper.




This resemblance to a melting ice cube is consistent with the rubbery bitumen filament above. It's likely that entangled molecular networks make it difficult to remove molecules from the surface of the dissolving bitumen.

These simple experiments challenge scientific assumptions about the solvent extraction of bitumen. The interpretation of lab experiments; the prediction of field scale performance; the impact of operating parameters like solvent type, heat, contaminants, etc., needed to be re-examined.

We developed a very sophisticated apparatus that allowed us to reproduce reservoir conditions and ran a series of experiments to track chamber growth rates. The tests[5] showed an extraction rate of 3 cm/day at 1004F (40°C). By comparison, at 446F (230°C) steam extraction in the Dover reservoir provides a chamber growth[6] rate of 1 cm/day.



So our "faster" than steam chamber growth rate, is only the thickness of one sheet of paper every 5 minutes. Why is this result exciting? Gravity drainage chambers have enormous surface area. The drainage chamber from a single wellpair has a surface area the size of 10 football fields. This corresponds to a large oil production rate.

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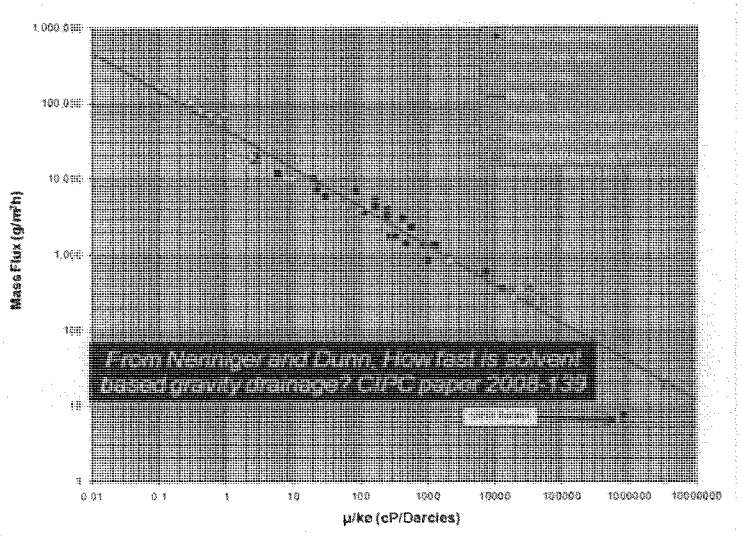
To make sense of our experimental data we compiled a data base of every solvent experiment that we could find in the scientific literature. We developed a correlation[7] (shown below) that predicted the oil rate as a function of experimental parameters. The data base includes experiments on many different types of crude at different temperatures and pressures, using different solvents and sand permeability's.




The simplicity of our correlation is surprising; the choice of solvent doesn't matter. The only fluid property that is important is the oil viscosity at extraction temperature. This again fits with the concept that it is difficult to remove large entangled molecules from the surface of the dissolving bitumen.

Our 3 cm/day laboratory result; fell on the same line as all the other experiments providing additional confirmation that our experiment was credible, and that a condensing solvent process operation at 104F (40°C) in Athabasca could provide oil rates as fast as a steam extraction process operating at 446F (230°C).

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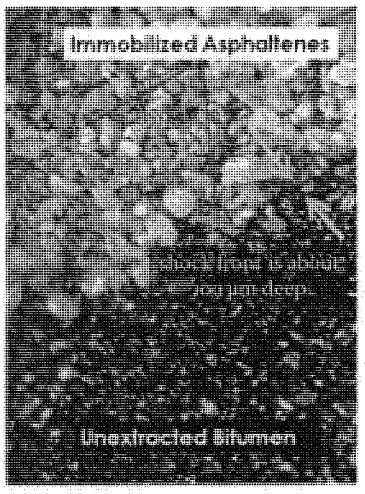


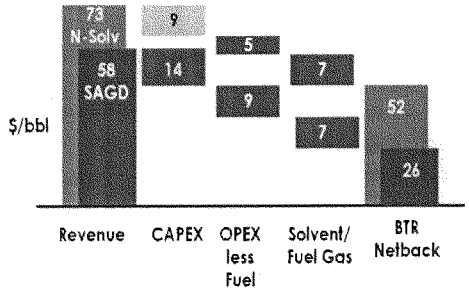

Our laboratory experiments consistently show a sharp boundary between the raw bitumen and the extracted sand in the solvent chamber. Typically this edge was exactly one sand grain thick (the thickness of one sheet of paper). Our experiments also show an unexpected result; the asphaltenes were uniformly distributed throughout the solvent chamber. This uniformity is important because the precipitated asphaltenes should not block the liquid drainage in the chamber.

Our experimental results have significant implications for the oil industry. It is likely that many solvent floods and miscible floods might not have achieved good mixing between solvent and oil. We think that production strategies that create lots of accessible surface area, like foamy heavy oil production, will be particularly suitable for subsequent solvent extraction[8]. Our results suggest that a current best practice waterflooding, may be quite harmful to ultimate oil recovery.

The US Geological Survey reports[9] that worldwide, there are about 3.4 trillion barrels of heavy oil with an expected ultimate recovery factor of only 13%. The use of solvents for heavy oil recovery may eventually grow to become a much larger opportunity than the oilsands.

## ECONOMICS OF SOLVENT EXTRACTION

It is early days for our solvent extraction process because we don't have field data yet. So discussion of N-Solv economic benefits is speculative. Furthermore, market prices for hydrocarbons are volatile and subject to change.




The graph compares N-Solv economics to those of steam extraction. The graph shows that N-Solv netbacks are twice as high as SAGD.

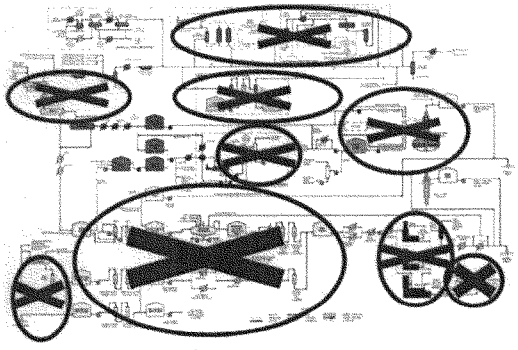
Capital cost is the riskiest portion of an oilsands investment because this cost is incurred many years

before there is any oil production. The profit to risk capital ratio is often used to assess the payout on an investment. In N-Solv, $9 of risk capital generates $52 of netback. In SAGD, $14 of risk capital generates $26 of netback. N-Solv is expected to produce three times more profit per dollar of investment capital.

Two aspects provide most of N-Solv's commercial advantage. The oil is more valuable because it is de-asphalted. Steam extracted bitumen suffers considerable shrinkage due to coke rejection. For every kilogram of synthetic crude production, 0.23 kg of coke is produced[10]. This coke has no commercial value; it's too dirty to burn without very expensive scrubbers De-asphalting removes most of the carbon residue and the metals that foul hydro-processing catalysts, so N-Solv oil should not need to be processed in a coker[11] and suffer coke shrinkage.

The shrinkage of SAGD bitumen in the coker reduces the yield of valuable products like gasoline. Thus, a barrel of N-Solv oil should be 23% more valuable than a barrel of SAGD bitumen. This value gain will be typically shared between producers and refiners, but can be fully captured by integrated oil companies.

The second great commercial advantage for N-Solv is the cost savings from process simplification. There is no boiler feed water treatment or steam generation. The process simplifications, shown by red x's in the figure to the left, reduce the capital cost of the N-Solv plant by almost 50% compared to a steam plant and provide a 50% reduction in operating expenses. The horizontal well costs for both processes are similar.



In SAGD and in N-Solv, each barrel of oil production needs to be replaced with some other fluid. We don't yet know the precise amount of solvent holdup for N-Solv. In SAGD, the holdup is about 0.1 bbl of water per bbl of oil production[12]. We have assumed the solvent holdup for N-Solv is twice the water holdup for SAGD. The cost of propane solvent is about $50/bbl, so a solvent inventory of 0.2 bbl/bbl corresponds to an inventory cost of $10 per barrel of oil production. The government provides a royalty rebate of 30% if solvent is re-injected into a reservoir. Thus, the net cash cost of using 0.2 bbl of solvent is about $7 or $8 per


barrel of oil. This calculation is pessimistic because it assumes that there is no recovery (even though we expect to recover most of it, because it is valuable).

We think our economics are highly understated. We have assumed twice the solvent inventory cost and have also assumed that the oil production is only one third of the predicted rates. We also assume the plant is assembled in the field. A factory assembled modular plant would provide substantial cost savings. No debt leverage has been assumed.

The ability to operate at a modest temperature and pressure will provide access to immense bitumen resources that are currently uneconomic for steam extraction. This resource includes "no-man's" land which is too deep to mine and too shallow to SAGD. Another stranded resource is the carbonates, a vast deposit with steam oil ratios that are currently uneconomic. N-Solv technology could help access 1,500 billion barrels of stranded bitumen resource within Alberta[13].

## ENVIRONMENTAL BENEFITS

N-Solv doesn't use any water. By comparison, steam extraction consumes about 1 bbl of water per bbl of oil production[14]. Although, only 0.1 bbl of water is required for in-situ voidage replacement, large amounts of water is sent to disposal wells because it is expensive to treat the water to achieve boiler feed specifications.

The big advantage of N-Solv is the reduced energy consumption due to operating the process at a temperature of 104F (40°C) instead of 446F (230°C). This reduces the emissions from the extraction by 85% compared to SAGD.

However this energy savings doesn't capture the entire story. SAGD bitumen produces less refined product per barrel than N-Solv due to coker shrinkage, so on a life-cycle basis N-Solv performs better than the 85% reduction. We have estimated that N-Solv will reduce the well to tank GHG intensity by 205 pounds (93 kg) per barrel of transportation fuel. This estimate has been externally validated by an outside and independent engineering firm. If we make some fairly modest assumptions about market growth and market share (30% share of in-situ, production ten years after commercialization), then N-Solv would reduce oil sands GHG emissions by 110 megatonnes, We expect the pilot to cost about $60 million dollars, so the average "cost "of GHG reduction is 50 cents per tonne

De-asphalting the bitumen in the reservoir has many benefits; it eliminates the coke disposal problem. Coke contains a number of carcinogens including polycyclic aromatic hydrocarbons and nickel. Using 85% less fuel than a SAGD, also enables N-Solv to reduce NOX and SOX emissions by 85%.

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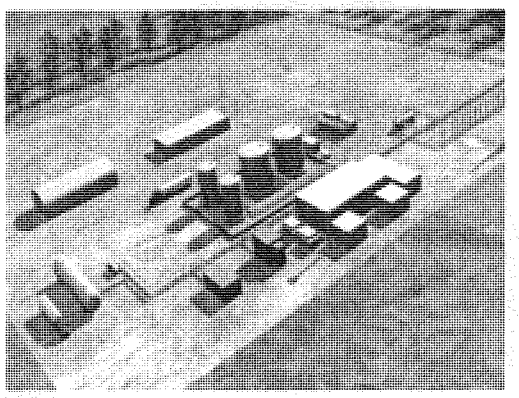
## THE "BEST" FIELD PILOT



We are building a $60 million field pilot to test the N-Solv technology in a reservoir setting. This is at the same site where SAGD was first piloted. We chose this site because there is a lot of published data on SAGD, so we can get a good comparison of the two processes.

Suncor Energy has kindly offered to host our pilot including drilling the wells. Hatch has made major investments in N-Solv, and is providing the Engineering. We have received major financial support from Sustainable Development Technology Canada. I can't say enough good things about SDTC; they have been tremendously supportive and patient through some difficult periods. Enbridge Pipelines has also contributed significant capital towards the pilot. These companies and SDTC have shown great leadership, they understood as far back as 2006, that development of cleaner oilsands technology was urgent.

We drilled seven observation wells in December 2011 and January 2012 to help understand the resource. These wells will be equipped with temperature and pressure sensors to track the chamber growth.

The pilot will use a 300 meter long well pair. This is shorter than a typical commercial scale well but long enough to see if we can achieve commercial scale productivity. The pilot is expected to operate for 3 years. The plant is designed for a maximum rate of 1500 bbls per day of solvent and 500 bbls per day of oil production.

Our analysis of the coring data from the observations wells is not yet completed. Our preliminary estimate is for an oil rate of 150 bbls of oil per day, which is one third of the rate predicted by the correlation. The plant design allows us to operate over a wide range of conditions, to facilitate learning as much as possible.

## SAFETY

Loss of solvent from the extraction zone represents a safety risk. However, there are three compelling reasons why N-Solv should always be operated to minimize the risk; solvent loss is dangerous, expensive and unnecessary.

The N-Solv process is somewhat like using a blowtorch to carve a tunnel in a block of ice. The melt water (oil) is continuously drained from the bottom of the tunnel. There is no oil revenue, unless the solvent is confined and the mobilized oil and condensed solvent can drain downwards to the production well.

We expect commercial extraction rates at modest temperatures and pressures, so there is no compelling commercial incentive to operate at pressures exceeding the native pressure. If an operator needs to raise the extraction temperature without exceeding a safe operating pressure, they can always switch from low boiling point solvent like propane to a higher boiling point solvent like butane.

In high temperature steam, the thermal expansion can swell the pay zone by 1 meter. This puts enormous stress on the confining cap rock layer. The modest extraction temperatures of N-Solv reduce the thermal expansion (and stresses) by about 10 fold compared to steam extraction.

The N-Solv plant is a hybrid of a standard natural gas plant and a heavy oil plant. Both of these operations are well known and have a well established track record of safe operation. Doubtless, we will climb a steep learning curve since N-Solv is a new technology. We follow or exceed all of the safety codes, and we have brought operators into our design team right from the start. The engineers have made a considerable effort to understand and fully address all of the operators concerns, especially if it relates to safety.

In summary, N-Solv produces a more valuable product for lower cost, because it is energy efficient and doesn't use water.

Thank you for the opportunity to present this information and I look forward to your questions and comments.

John Nenniger

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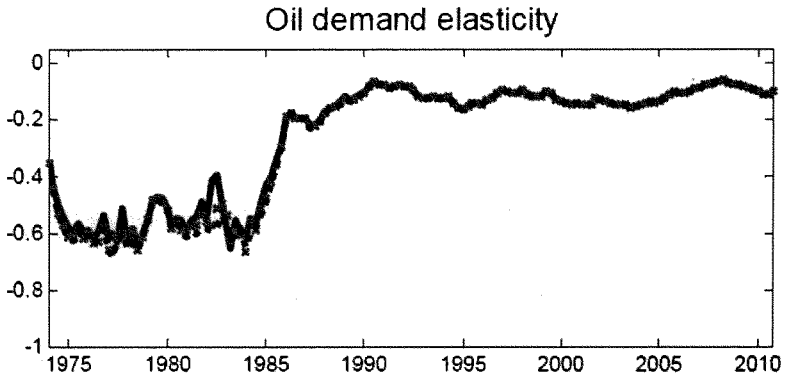
[1] Nenniger,J; Polycyclic Aromatic Hydrocarbon Production in a Jet Stirred Combustor http://dspace.mit.edu/handle/1721.1/15501

[2] Nenniger, E., Hydrocarbon Recovery, http://brevets-patents.ic.gc.ca/opic-cipo/cpd/eng/patent/1059432/page/1059432_19940423_coverpage.pdf

Dunn, Nenniger, Rajan; A Study of Bitumen Recovery Using Low Temperature Soluble Gas Injection http://onlinelibrary.wiley.com/doi/10.1002/cjce.5450670617/abstract

[3] See Figure 5 of Baumeister, Peersman The role of Time Varying Elasticities in Accounting for Volatility Changes in the Crude Oil Market http://www.bankofcanada.ca/wp-content/uploads/2011/11/wp2011-28.pdf




According to the Bank of Canada, elasticity of demand, $E_d$ for crude oil is about -0.1. Elasticity of demand is defined as;

$$E_d = \frac{\% \text{ Change in Quantity Demanded}}{\% \text{ Change in Price}}$$

So, a loss of 1 million bopd of crude production from Libya or any other place, means that world-wide demand must be cut by -1.1%=-1/90. Using the formula, this loss of oil demand will only be achieved if the oil price rises by 11% (= -1.1%/-0.1). Consequently, the oil price must increase by $11, from $100 to $111/bbl. If the current consumption is 18 million bopd in the US, then a shortfall of 1 million bopd will cost US consumers $200 million/day (= 18 million bopd x $11/bbl) even if there is not a drop of Libyan oil being consumed in the US.

Consequently, each barrel of oil deficit anywhere in the world costs US consumers $200 (=$200 million/1 million bopd). Thus, a 1 barrel surplus, created by a consumer who drives a fuel efficient car, creates $300 of value; $100 for the reduced oil consumption and $200 for reducing the cost of fuel to other US consumers.

Thus new supply might cost $100 per barrel, yet provide a "surplus" which lowers the value of the other 18 million barrels consumed daily by $200. Thus, the net benefit of new supply to US consumers is +$100/bbl.

[4] Das; Diffusion and Dispersion in the Simulation of Vapex Process http://www.onepetro.org/mslib/app/Preview.do?paperNumber=SPE-97924-MS&societyCode=SPE

[5] Frauenfeld, et al., Evaluation of the N-Solv Process – Experimental operation and Results http://www.n-solv.com/documents/ARC_NSolv_Report_June22_05.pdf

[6] The oil production rate for the UTF Phase B Pilot was 100 $m^3$ of bitumen per day for a 500 m wellbore in 20 m of pay, which corresponds to a lateral chamber growth rate of about 1 cm per day.

Maini and Ahearne; Fluid Movement in the SAGD Process: A Review of the Dover Project http://www.onepetro.org/mslib/app/Preview.do?paperNumber=PETSOC-2006-153&societyCode=PETSOC

[7] Nenniger, Dunn; How Fast is Solvent Based Gravity Drainage? http://www.n-solv.com/documents/CIPC2008-139.pdf

[8] Nenniger, J; A Multi-step Solvent Extraction Process for Heavy Oil Reservoirs http://brevets-patents.ic.gc.ca/opic-cipo/cpd/eng/patent/2688937/page/2688937_20110620_coverpage.pdf

[9] The USGS reports that technically recoverable heavy oil is 434 billion barrels with 2834 billion barrels stranded (uneconomic to recover). Technically recoverable Bitumen is 651 billion barrels with 2,210 billion barrels stranded. Better technology and/or higher prices will allow a portion of this stranded resource to be recovered economically. See Meyer, Attanasi; Heavy Oil and Natural Bitumen – Strategic Petroleum Resources, http://pubs.usgs.gov/fs/fs070-03/fs070-03.pdf

[10] The Energy Resources Conservation Board publishes an annual report titled ST98 Alberta's Energy Reserves and Supply/Demand Outlook. The 2011 version reports 1.8 billion barrels in place of which 1674 billion bbls are considered to be in-situ resource and 138 billion bbls of this in-situ resource is considered economic to recover. Thus, 1536 billion barrels of in-situ bitumen are stranded. http://www.ercb.ca/docs/products/STs/st98_current.pdf

[11] See figure 4 of Phillips, Liu; Advances in Upgrading Technologies Offer Refiners Cost Effective Options http://www.fwcparts.com/publications/tech_papers/files/ERTC%202002%20-%20RESIDUE%20UPGRADING%20ARTICLE.pdf

[12] The reservoir holdup for SAGD is calculated using the difference between the quantity of injected steam and the quantity of produced water and published by the Energy Resources Conservation Board in an annual report called ST53. Based on the Data from ST53-2009, 114,629 m3/day of steam was injected and 110,737 m3/day of water was produced for a holdup of 3,892m3/day. The oil production was 38,442 m3/day, so the reservoir holdup was 0.1 m3 water per m3 oil. This calculation assumes that the projects operate at reasonable pressures so they are not losing steam to thief zones. http://www.ercb.ca/portal/server.pt/gateway/PTARGS_0_0_308_265_0_43/http:/ercbContent/publishedcontent/publish/ercb_home/publications_catalogue/publications_available/serial_publications/st53.aspx

[13] The energy resources conservation board publishes an annual report titled ST98 Alberta's Energy Reserves and Supply/Demand Outlook. The 2011 version reports 1.8 billion barrels in place of which 1674 billion bbls are considered to be in situ resource and 138 billion bbls of this in situ resource is considered economic to recover. Thus, 1536 billion barrels of in situ bitumen are stranded. http://www.ercb.ca/docs/products/STs/st98_current.pdf

[14] This information was downloaded from the Oilsands Information portal from Alberta Environment http://environment.alberta.ca/apps/osip/ downloaded Dec 2011, which includes SAGD bitumen production data as well as fresh and brackish water use until the end of 2010. This data set is incomplete because it does not include all SAGD plants, but it is thought that the data set is large enough to be somewhat representative of overall SAGD industry performance. Of the reported SAGD plants, cumulative water use was 47,036,455m3 and cumulative bitumen production was 48,816,405m3 for a water use/oil production ratio of 1

Mr. WHITFIELD. Thank you very much.

And Mr. McCaffrey, you are recognized for a 5-minute opening statement.

**STATEMENT OF WILLIAM MCCAFFREY**

Mr. MCCAFFREY. Mr. Chairman, Congressmen, thank you very much for the opportunity to speak today about technology and the energy industry in Canada.

I am Bill McCaffrey; I am the president and CEO of MEG Energy, and today I am here representing In situ Oil Sands Alliance. And this is a group of independent Canadian companies dedicated to the responsible development of the Canadian oil sands using in situ technology. The main in situ technology used today is steam-assisted gravity drainage, or SAGD, as it is called. And SAGD is important because it is currently the most common commercially proven—pretty much the only commercially proven way to reach the deep reservoirs that contained 80 percent of Canada's total oil sands reserves. And just to put that into perspective, that represents about 140 billion barrels of reserves, roughly equivalent to the entire reserves of Iran.

Now SAGD technology is pretty simply, really. It uses horizontal wells drilled from surface and we drill down to about 1,000 feet below the Earth's surface. Once we reach the reservoir and complete the wells, we drill about half a mile out, inject steam into the reservoir, and bring the heated oil and the water back to surface without disturbing the forest floor. And from a well pad a fraction the size of this building, the subsurface equivalent of 95 NFL football fields can be accessed. This provides what is among the lowest ratios of surface disturbance to resource recovery in the oil and gas industries anywhere in the world. About 90 percent of the water that is used to create the steam is recycled with the portion we can't recycle returned to deep, non-potable reservoirs. There are no tailing ponds created and it is essentially a closed-loop system.

In going forward, one of the key research and development focuses is to reduce the amount of energy we need to produce a barrel of oil. That is critical because of both the emissions and costs associated with the energy consumption. One of the technologies we are currently applying alongside of the SAGD is cogeneration, a very energy-efficient process that produces both steam for our operations and electricity for the sale to the grid. And that electricity has a carbon footprint less than half the Alberta grid average, reducing greenhouse gas intensities in the province.

And in 2011, just as an example, MEG's cogeneration contribution alone was equivalent to taking 80,000 cars off the road. That kind of benefit is continuing to grow as co-gen replaces legacy plants that have reached the end of their useful life. In our case, when we factor in the benefits of cogeneration and efficient steam use, SAGD can produce a barrel with the wells-to-wheels carbon footprint about 6 percent below the average U.S. imports.

And as we look to the future, the industries investing in many other innovative technologies, nearly all of which share the same common goal—and you will hear that today—is to improve energy efficiency, it is to drive down emissions, and it is to increase resource recovery rates. And I underline one point. SAGD is just 10

years old. It is a young technology. It has been in commercial operations for about 10 years. But the point out of it is there remains tremendous opportunity for innovation to further accelerate the strides that have already been made.

Looking beyond resource recovery, we are also working with Canadian and U.S. research groups on technology to customize our export barrels. The goal is to better align these barrels with the configurations of U.S. refineries offering significant improvements in refinery efficiencies and economics and the jobs that come with them. These technologies can also support more efficient lifecycle fuel use. For example, barrels can be tailored to be an ideal feedstock in the creation of ultralow sulfur diesel, a friendlier fuel option that many U.S. automakers are now targeting.

Government can have a role in partnering with industry to encourage technology acceleration, a topic I know several of the other panelists are talking about here. But I would also note that the government also has a necessary and a critical role as a regulator. While still maintaining the highest standards, we need to streamline the regulatory processes so that windows of opportunity to invest and innovate are not missed.

And to conclude, innovation, collaboration, and regulatory efficiencies are all critical to our economy today and into the future. With the oil sands industry alone, the prize for the United States is an increase in goods and services output projected to reach $45 billion a year by 2035 and the creation of nearly half a million American jobs in that same time period.

And finally, I would just argue that it is of our mutual interest in terms of economic stability, environmental responsibility, and energy security to work together. The focus of this committee on harnessing technology to realize these goals to me is entirely appropriate. And I thank you for the time today.

[The prepared statement of Mr. McCaffrey follows:]

Testimony to House Energy and Commerce Committee

Subcommittee on Energy and Power

Chairman Ed Whitfield (R-KY)

**"The American Energy Initiative"**

By

William (Bill) McCaffrey
President and CEO
MEG Energy Corp.

Presented March 20, 2012

**Summary of Testimony of**
**William (Bill) McCaffrey, President and CEO of MEG Energy Corp.**
**on behalf of the In Situ Oil Sands Alliance**

The in situ sector of Canada's oil sands industry is a technologically-driven and highly innovative business. The leading in situ technology, steam-assisted gravity drainage or "SAGD", provides a commercially proven means of accessing approximately 140 billion barrels of oil – equal to the entire reserves of Iran.

SAGD uses a number of innovative technologies.

- Horizontal drilling allows access to a large resource base with minimal surface disturbance. The ratio of disturbance to developable resource is among the lowest in the oil and gas industry, globally.
- Advanced water treatment technology allows for recycling of 90% of the water used to produce steam for the SAGD process. No tailings are created and water that cannot be recycled is returned to deep, non-potable reservoirs similar to those from which it is sourced. It is essentially a closed loop.
- Natural gas fired cogeneration technology provides the steam needed for the SAGD process, while also providing electricity to the consumer grid with a carbon footprint less than half the Alberta provincial average. Continuing development of cogen in future SAGD projects will further lower the Alberta provincial grid's carbon intensity.

Technologies under development focus largely on reducing the steam to oil ratio (SOR) in SAGD operations. Reducing SOR reduces energy use (and therefore emissions intensity), water handling and recycling requirements, as well as the related costs thereby improving the economics of resource recovery. The benefits a low SOR, combined with cogeneration, yield a barrel of oil that today is 6% lower in carbon intensity that U.S. import average.

In addition, research underway is seeking to advance technology to customize oil sands export barrels. The goal is to better align those barrels with the configuration of U.S. refineries, offering significant improvements in refinery efficiency and economics and the jobs that come with them. This technology may also yield benefits in tailoring barrels to create an ideal feedstock for the creation of ultra-low sulfur diesel fuels, which provide an improved life-cycle carbon footprint.

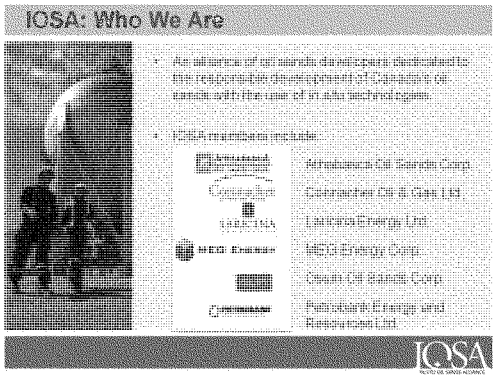
As SAGD and related technologies are still relatively early in their development curve, there is significant potential for further improvement in carbon intensity and other environmental and economic performance metrics. Realizing these benefits may be accelerated through collaboration of government, academia and industry. In addition to research and collaboration, streamlined but still comprehensive, regulatory processes that do not unduly hinder investment and innovation will be key to reaching the full potential of SAGD oil sands development.

For the United States, continuing oil sands development offers a secure source of energy and also provides substantial benefits to the U.S. economy. These include an increase in goods and services output projected to reach $45 billion per year by 2035 and the creation of nearly half a million American jobs in that same time frame.

**Written Submission**

Thank you for this opportunity to discuss technology in the energy industry in Canada. This is a discussion that is both timely and of tremendous importance.

I'm Bill McCaffrey representing the In Situ Oil Sands Alliance -- a group of independent Canadian companies dedicated to responsible development of Canada's oil sands using in situ technologies.



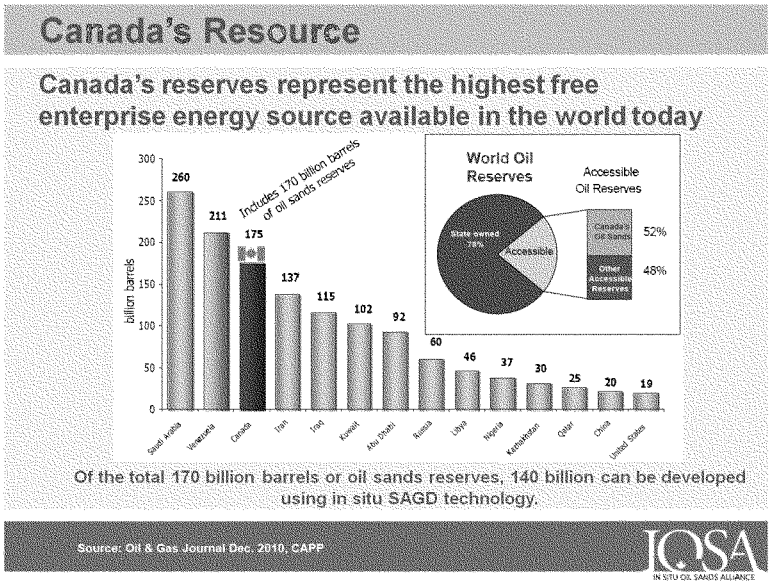

From a personal background, I wanted to mention that my career in the industry began with Amoco, who were early leaders in oil sands technology. I mention this because Amoco's historical role in Canada's energy sector – a role which I am proud to be part of -- is a great example of the kind of cross-border investment that supports our mutual energy security and job creation needs.

After leaving Amoco in 1999, I co-founded a company called MEG Energy. Today, we produce 30,000 barrels per day and have a market value of about $8 billion dollars.

The time since MEG's inception has been a story of technology and innovation in unlocking economic potential and driving environmental improvements. My submission is mainly from a perspective of my own experience in that story, and this is only as an example of developments that are occurring in

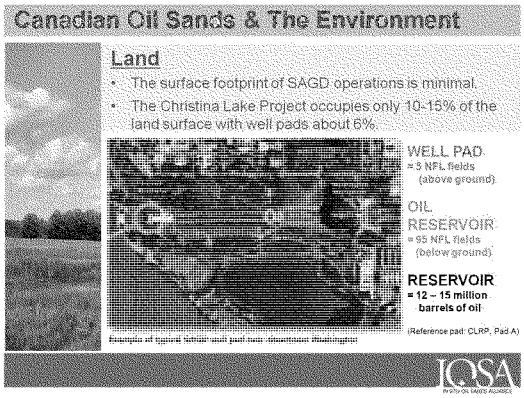
today's oils sands and the opportunities they create for the United States in the areas of energy security, employment and economic stability.

To start, I'd like to focus on a technology called steam assisted gravity drainage, or SAGD technology. SAGD is important because it is currently the only commercially proven way to reach deep oil sands reservoirs that contain 80% of the total Canadian oil sands reserves. To put that in perspective, that 80% represents about 140 billion barrels -- roughly equivalent to the entire reserves of Iran.



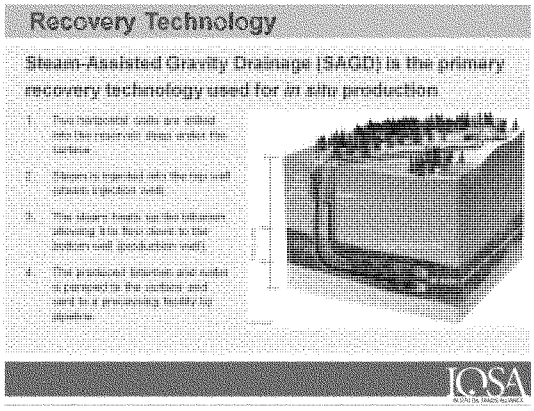

If the oil sands were to meet its economic potential in terms of production volumes, maintaining shipping through the Strait of Hormuz would not be the threat to American energy supply it represents today.

**SAGD TECHNOLOGY**




Without getting into too much technical detail, SAGD technology uses horizontal well pairs drilled from the surface to about 1,000 to 1,500 feet below the ground. With a pad draining an average 10 to 12 million barrels from the reservoir, this is now among the lowest ratios of surface disturbance to resource recovery in the oil and gas industry anywhere in the world.

With SAGD technology, In the subsurface wells, the top well injects steam to heat the bitumen, allowing it to drain to the lower well where it can be pumped to the surface using conventional technology, and then processed and shipped to markets.




About 90% of the water used to create steam is reused, with its residual heat captured for energy efficiency. The portion we can't recycle is returned to deep, non-potable reservoirs similar to those from which it was sourced.

There are no tailings ponds created and it is essentially a closed loop system. In fact, if you toured our facilities (and you are invited to so), you would see what looks like a water treatment plant.

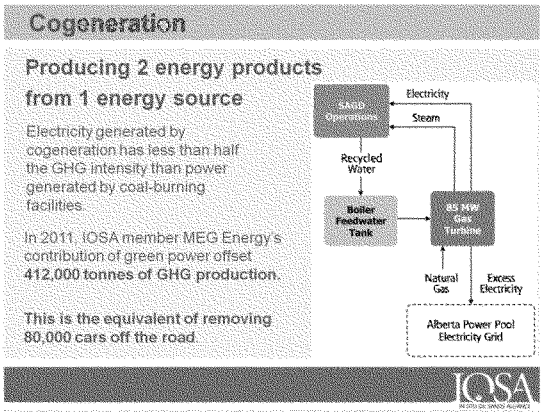
While the environmental performance of SAGD is solid, we do face some challenges. These challenges can be encapsulated in a key metric in our industry – known as the steam-oil ratio, or SOR. SOR is the amount of steam we send down the well relative to the amount of crude oil we get back.

It's an important metric because it captures three other critical measures:

- The amount of energy we use to create steam and the associated emissions.
- The amount of water we put through our systems and the required treatment for reuse.
- And -- because we are a business – the costs of energy and water management.

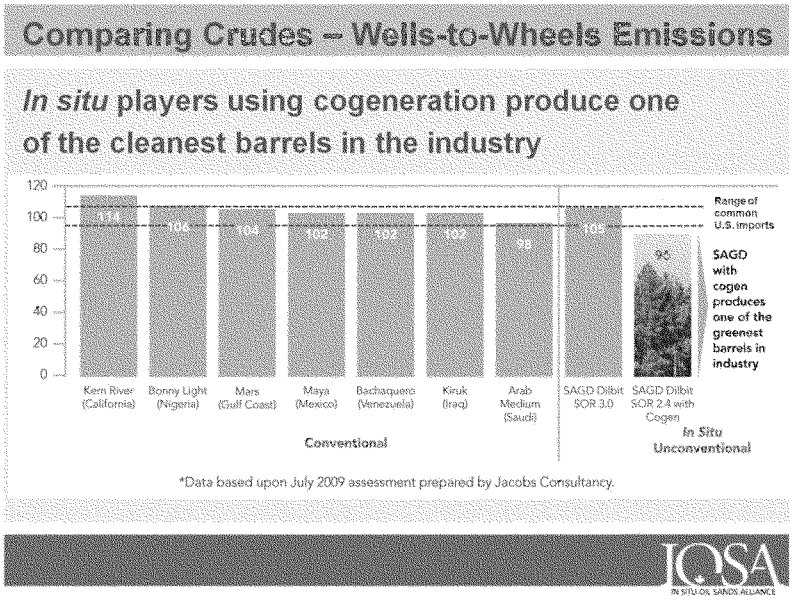
That simple view underlines why reducing SOR is a major focus of research.

One of the technologies we currently apply to the steam side of the equation is cogeneration – a very efficient process that uses clean-burning natural gas to produce both steam and electricity. The steam is used in our process, while excess electricity is sold to the grid.



That electricity has a carbon footprint less than half the Alberta grid average, helping to reduce total greenhouse gas intensity in the province. In 2011, MEG's cogeneration contribution alone was equivalent to taking 80,000 cars off the road. That kind of benefit will continue to grow as cogen replaces legacy plants that have reached the end of their useful lives.

In MEG's case, when factoring in the benefits of cogeneration and a low SOR, SAGD can produce a barrel with a "wells to wheels" carbon footprint about 15% lower than California heavy and about 6% lower than the average of U.S. imports.



As we look to the future, we are also investigating other innovative technologies. To name just three:

- Trace amounts of natural gas can be injected into mature wells to replace a portion of the steam energy component and maintain pressure in the reservoir. This substantially improves energy efficiency, lowering SORs and driving down emissions. The gas is recovered with the bitumen and cycled back into the process.
- Using "infill wells" guided by high-tech directional drilling, we can place a horizontal collector well in the sweet-spot between existing wells, increasing recovery and lowering our SORs.
- Solvent injection technology is yet another way to improve energy efficiency. That technology is well represented on the panel today.

There are many other examples. To cover them all would require a very large submission, but I would underline this point: SAGD is a proven, but still young technology -- only about 10 years old on a commercial basis. There remains tremendous opportunity for innovation and improvement to further accelerate the strides we've already made.

Looking at technology opportunities beyond our plant site, we are collaborating with Canadian and U.S. research groups to advance technology to customize our export barrels. The goal is to better align those barrels with the configuration of U.S. refineries, offering potentially significant improvements in refinery efficiency and economics and the jobs that come with them.

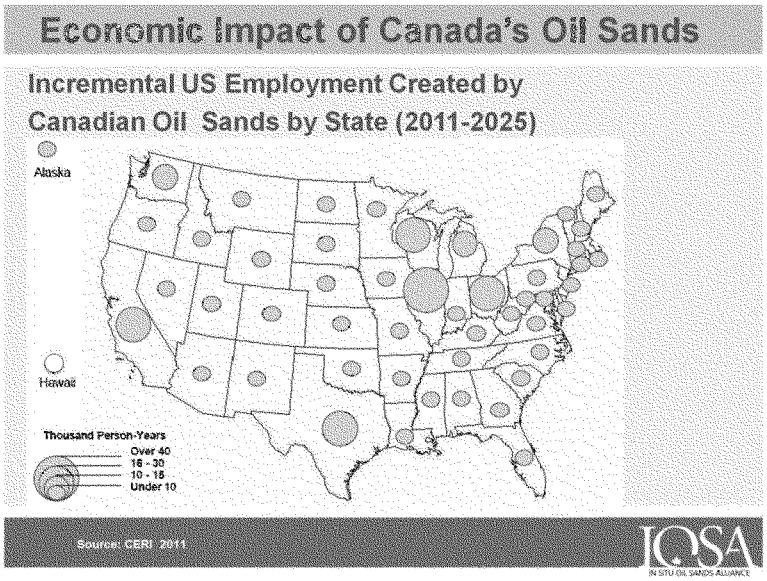
These technologies can also support more efficient life-cycle fuel use. For example, these barrels could be tailored to be an ideal feedstock in the creation of ultra-low sulfur diesel – a friendlier fuel option that many U.S. auto makers are now targeting.

Governments can have a role in encouraging technology acceleration. SAGD itself was pioneered by a public-private research partnership: the Alberta Oil Sands Technology and Research Authority, or

AOSTRA. AOSTRA pioneered the technology, but it took the collaboration of industry expertise and capital to develop it to commercial success. Similar efforts, such as "Alberta Innovates" represented today by Dr. Issac, continue to play an important role in the next generation of innovation. Industry, academia and governments – including governments on both sides of our shared border – all have a role in driving technology.

Governments also have a necessary and critical role as regulators. Good regulation must ensure protection of the public interest, without being too burdensome or arbitrary as to hinder economic growth and damage the public interest. We need to streamline regulatory processes, while still maintaining the highest standards. Regulation must be comprehensive – but it must also be efficient so that windows of opportunity to invest and innovate are not missed.

To conclude, innovation, collaboration and regulatory efficiency are all critical to our economy today and in the future. Looking at the oil sands industry alone, the prize for the United States is seeing an increase in goods and services output projected to reach $45 billion per year by 2035 and the creation of nearly half a million American jobs in that same time frame.




Canada and the United States have a tremendous history working together across our borders to our mutual benefit. This has particularly been the case with energy and today I would argue that our mutual interest in economic stability, environmental responsibility and energy security is stronger than ever. The focus of this committee on harnessing technology to realize those goals is entirely appropriate and I thank you for your time today.

This document refers to two substantial volumes of research which can be accessed at the following links:

Jacobs Consultancy Canada Wells-to-Wheels http://www.ai-ees.ca/home/initiatives/projects/lca

Canadian Energy Research Institute: The Impacts of Canadian Oil Sands Development on the United States' Economy http://www.scribd.com/doc/21296235/CERI-The-Impacts-of-Canadian-Oil-Sands-Development-on-the-United-States%E2%80%99-Economy

**Canadian Energy Research Institute**

# The Impacts of Canadian Oil Sands Development on the United States' Economy

**FINAL REPORT**

**October 2009**


Relevant • Independent • Objective

# THE IMPACTS OF CANADIAN OIL SANDS DEVELOPMENT ON THE UNITED STATES' ECONOMY

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October 2009

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## EXECUTIVE SUMMARY

**Background:** CERI, a non-profit Canadian energy and environmental research institute, examines the impacts of developing Canadian oil sands on the United States' economy. The study covers the period from 2009 to 2025 and is based on the 2009 CERI "Economic Slowdown Projection". This production forecast envisions raw bitumen production slowly climbing from current levels of approximately 1.2 million barrels per day to around 4 million barrels per day in 2025. CERI estimates the capital investment and operating costs needed during the 2009-2025 period to achieve this output at $379 billion. This study estimates the impact to the US economy of these investments and related oil sands production occurring in Alberta, Canada.

**Results:** Canada and the US are major trading partners, and the results clearly show significant economic benefits to the US from increased economic activity in Canada. As investment and production in oil sands ramps up in Canada, the pace of economic activity quickens and demand for US goods and services increase rapidly, resulting in an estimated 343 thousand new US jobs between 2011 and 2015. Demand for US goods and services continues to climb throughout the period, adding an estimated $34 billion to US GDP in 2015, $40.4 billion in 2020, and $42.2 billion in 2025.

| National Impacts ($US Billion) | 2010 | 2015 | 2020 | 2025 |
|---|---|---|---|---|
| U.S. Output | 23.0 | 69.2 | 78.5 | 80.9 |
| U.S. Gross Domestic Product | 11.5 | 34.0 | 40.4 | 42.2 |

| National Impacts (Thousand Person Year) | 2009-2010 | 2011-2015 | 2016-2020 | 2021-2025 |
|---|---|---|---|---|
| U.S. Employment | 172 | 343 | 88 | 22 |

"Thousand Person Year" equates to the number of jobs created, times 1,000, for a given year and for as long as the project operates. With regards to the table above, the number of jobs listed indicates the number of incremental jobs that are created. For example, between 2011 and 2015 an incremental 343 thousand jobs are created.

The benefits of oil sands development do not fall to any one industry or any one region in the US but are broadly shared across many industrial sectors and regions. This is because oil sands development requires a large quantity of inputs from broad segments of the manufacturing and service sectors of the Canadian and US economies. It is this increase in demand for goods and

services in both countries, and the increased trade resulting there from, that broadly increases the level of economic activity to the United States.

**Conclusions:** Developing the Canadian Oil Sands is a very capital intensive endeavor, requiring billions of dollars of investment over the next several decades. This investment would give rise to a long-lived, robust period of increased economic activity in Canada. Due to the deep and rich trading relationship between Canada and the United States, the US derives significant benefit from this increased economic activity across many sectors throughout the United States.

# CHAPTER 1
# INTRODUCTION

## 1.1 Background

Amidst a global financial crisis, uncertain commodity prices and an unclear geopolitical landscape, the public in both the United States and Canada are expecting policy-makers to formulate a balanced set of energy and environmental policies. More specifically with respect to the issue of Canadian oil sands, a clear understanding of the contribution of oil sands development to the US economy in terms of jobs, economic growth and energy security will hopefully inform the public debate. This understanding is crucial as the petroleum industry is characterized by capital-intensive projects with long lead times. Policy decisions made today can have large impacts on investment levels and energy supply for decades into the future,

Canada's petroleum industry is a significant contributor to both Canadian and US Gross Domestic Product (GDP). The petroleum industry has widespread economic impacts that extend far beyond the province of Alberta—Canada's largest producer of oil and gas. Investments in new developments and expenditures in ongoing operations provide jobs that generate multiplier effects across economic sectors and borders, benefiting all regions of Canada and the US..

## 1.2 Objective of the Study

Canada is one of the most important energy producers in the world and the largest supplier of petroleum to the US—a fact that is often not realized. While other regions of Canada are attracting a lot of attention and offer tremendous potential for export, the heart of the Canadian industry is located in the western province of Alberta. It is well known that Canada's most important energy resource is the oil sands, located predominantly in Alberta, but stretches into neighbouring Saskatchewan. With an estimated initial volume in-place of approximately 1.7 trillion barrels of crude bitumen, Canada's oil sands are one of the largest hydrocarbon deposits in the world and provide the most secure supply to the US. By year-end 2008, about 10 percent (i.e., 170.4 billion barrels) of this volume is recoverable using today's technology. Of this recoverable bitumen reserves, 18 percent is accessible through surface mining technologies, while the remaining 82 percent requires in situ recovery technologies.

The oil sands are receiving increasing attention, especially as conventional oil production declines and demand for oil increases. As a result, oil sands reserves play an increasingly important role in the economic development of Alberta, Canada and the United States. What is often not clearly understood is that the large investment in the oil sands industry contributes to increased economic activity in the rest of North America by stimulating demand for goods and services across a wide range of industries.[1] The same is true for other investments in the oil and natural gas industries in any province, state or territory, be it British Columbia, Texas or Newfoundland.

[1]Inventory of Major Alberta Projects, September 2008.

## 2 The Impacts of Canadian Oil Sands Development on the United States' Economy

What are the impacts of a certain investment on output of goods and services, GDP, and employment? More specifically, what are the economic impacts of hydrocarbon developments on key macroeconomic variables such as output, GDP, and employment in a particular state? Is there any way to quantify those impacts? How can we study the impacts of such investments on macroeconomic variables in other states? As a result of investment in the oil sands, how many new jobs would be created in Ohio? Providing answers to such questions requires economic tools sufficiently rich in detail to track economic transactions across industries, regions and international borders.

The Canadian Energy Research Institute (CERI) has conducted a number of Input–Output (I/O) analyses, the latest of which was a comprehensive assessment of the contributions of Canada's petroleum industry to the Canadian economy in terms of output, employment and government revenue, both at the provincial and national levels. Released in July 2009, this study focused entirely on Canada.

The primary objective of this study is to measure the incremental impacts of the development in the oil sands industry and the resulting impacts on all US states and the US as a whole. The current study builds on CERI's previous I/O work, focusing only on the Canadian oil sands industry and its importance to the US economy. In particular, CERI examines the impact that the oil sands have on other industries in the US by assessing industry output, GDP, and employment impacts. It identifies the direct, indirect, and induced impacts (discussed in Chapter 3) of current and future investments in Canada's oil sands industry.

This study, like its predecessor, utilizes the I/O modeling approach, which is well established in the literature to determine the impacts of investments in an industry on the operations of other industries. I/O analysis considers relations between industries in an economy and tracks the output of one industry as input into other industries.

Using the I/O accounts published by Canada's System of National Economic Accounts (CSNEA) and Bureau of Economic Analysis's (BEA) *Make*, *Use* and *Final Demand* of the US economy, CERI has constructed a United States-Canada Multi-Regional I/O model (UCMRIO) for the US and Canada. Appendix A discusses further the details of the methodology.

CERI's UCMRIO model reveals the details of the economic linkages between the US and Canadian economies. For instance, it identifies the GDP impact of investment in the oil sands on the economy of Alberta, other Canadian provinces and US regions as well as the national, impacts of the total investments and production of each sector of the economy.

This study sheds light on the Canadian oil sands industry and its importance to the US economy, assisting policy-makers to make informed decisions regarding this industry. Furthermore, it informs the public about an important industry that is not well understood.

### 1.3 Structure of the Report

This report has been structured as follows. Chapter 2 discusses briefly the oil sands industry in Canada and addresses several key facts about the industry. This chapter sets an important foundation to understanding this massive and unique resource. Chapter 3 discusses and presents the economic impacts of oil sands development on the US economy. The report also contains two appendices. The first discusses in-depth the methodology of this study. It is divided into four parts: overall modeling framework, the USMRIO model, data sources and assumptions and limitations of the I/O approach. The second provides additional information regarding the Canadian oil sands.

## CHAPTER 2
## OIL SANDS INDUSTRY IN CANADA

This chapter discusses the oil sands industry in Canada. It is divided into two sections: background and oil sands production and investment projection. A discussion of crude bitumen reserves and mineable crude bitumen reserves (under active development) are in Appendix A.

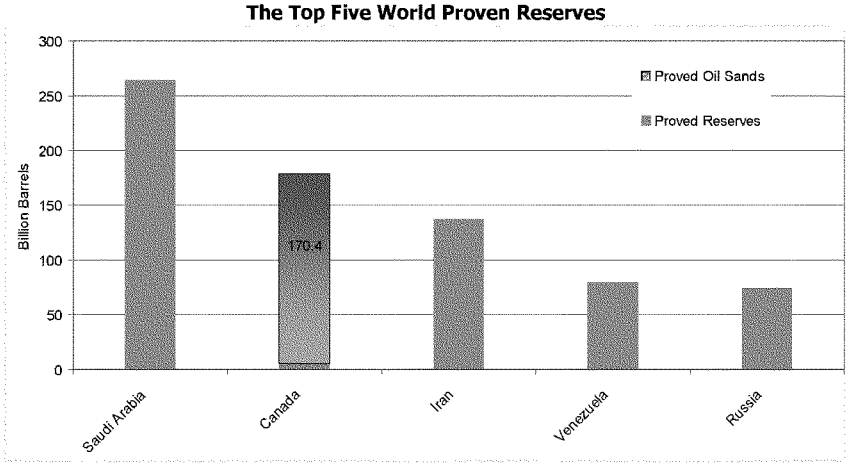
### 2.1 Background

As reserves and production of conventional crude oil decline, unconventional resources have moved to center stage in Canada, and are becoming increasingly important to the global oil industry. As previously mentioned, with an estimated initial volume in-place of approximately 1.7 trillion barrels (269 billion $m^3$) of crude bitumen, Canada's oil sands are one of the largest hydrocarbon deposits in the world.[2] While not quite matching Saudi Arabia's conventional oil reserves, the enormous remaining established reserves of Canada's crude bitumen places Canada in the top tier of the world's oil reserves (see Figure 2.1). [3] The resource places Canada second to only Saudi Arabia in total reserves, cutting the Organization of Petroleum Exporting Countries' (OPEC's) share of world oil reserves by more than 10 percent.

[2]Alberta Energy and Utilities Board, *Alberta's Reserves 2005 and Supply/Demand Outlook 2006 – 2015,* June 2006. Latest numbers from Alberta Energy indicate that, due to production, proved oil sands reserves are 170.3 billion barrels. The disparity does not affect the results.

[3]The BP Group, *BP Statistical Review of World Energy 2003,* www.bp.com. Saudi Arabia's proved oil reserves at the end of 2002 stood at 261.8 billion barrels. Proved reserves are generally taken to be those quantities that geological and engineering information indicates can be recovered in the future from known reservoirs under existing economic and operating conditions with reasonable certainty.

**Figure 2.1**
**The Top Five World Proven Reserves**



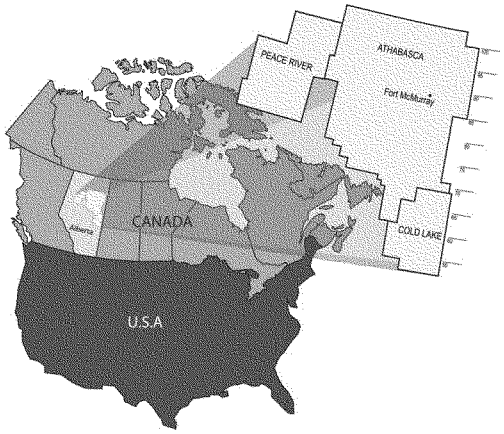

SOURCES: (1) Statistical Series 2003-98, Alberta's Reserves 2005 and Supply/Demand Outlook 2006-2015, (AEUB); and (2) BP Statistical Review of World Energy 2006.

Predominantly located in northern Alberta in the Western Canada Sedimentary Basin (WCSB), Canada's oil sands resources are spread across more than 140,000 square kilometers (see Figure 2.2).[4] They are primarily contained in sand and carbonate formations that are located in the following areas:

- Athabasca in the northeast;
- Cold Lake in the east-central; and
- Peace River in the northwest parts of the province.

[4] Oil sands deposits also exist in Saskatchewan.

**Figure 2.2**
**Oil Sands Areas in Alberta**




SOURCE: Alberta Department of Energy.

The oil sands areas in fact stretch east into the neighbouring province of Saskatchewan. As their timescale is not within the scope of this study and are still being delineated, they are not included in this study. However, while far less known than its Albertan counterpart, oil sands in Saskatchewan are attracting a great deal of attention as well and it is important to discuss them briefly. The oil sands in Saskatchewan are found in the lower cretaceous Dina Formation, which extends from Alberta's McMurray Formation.

The first interest in Saskatchewan's oil sands took place from 1974 to 1976 in Clearwater River Valley, located in the northwestern part of the province. During that period, drilling activity started by Shell Canada and Gulf Canada in which they identified the bitumen deposits. Exploitation of the resource, however, was ruled uneconomic due to technological limitations. Nearly thirty years later, in June 2004, the interest for the oil sand deposits in the region was renewed, when Powermax Energy Inc. of Calgary acquired approximately 570,000 hectares, north of the Clearwater River.[5] The area of interest, located along the Alberta-Saskatchewan border, is just north of the Cold Lake Weapons Range. Oilsands Quest Inc. later acquired these land permits, in which they relinquished 228,000 hectares and soon after started drilling exploration wells in the remaining 342,000 hectares of the region. By November 2007, 221 wells have been drilled and an initial report of about 1.5 billion barrels of bitumen was noted and in June 2008, Oilsands Quest nudged that number up to 6.6 billion barrels. The area of the original discovery by Oilsands Quest is now called the Axe Lake Discovery in which three reservoir test sites began construction in March of 2008 and plans for placing horizontal wells should commence in 2009.

[5] "Oil Sands in Saskatchewan", Saskatchewan Industry and Resources, 2005.

The remainder of the report focuses on the oil sands in Alberta.

Canada's oil sands are composed of approximately 80 to 85 percent sand, clay and other mineral matter, 5 to 10 weight percent water, and anywhere from 1 to 18 weight percent crude bitumen. Bitumen content greater than 12 percent is considered rich, while anything less than 6 percent is poor and not usually considered economically feasible to develop.

In the Athabasca region, the oil sands are hydrophilic or "water wet". A thin film of water, which is surrounded by crude bitumen, envelops each grain of sand. The sands are unconsolidated with grain-to-grain contact. Being silica quartz, the sands are extremely abrasive, thus posing significant challenges in the mining and extraction processes. Early developers of the oil sands experienced the challenges associated with this abrasive product, damaging pipelines and equipment. This resulted in alternative methods to transport the bitumen in pipelines, such as creating bitumen emulsions and adding large quantities of water into pipelines for hydro transport. These and other innovative initiatives helped turn the resource into a viable source of oil.

Crude bitumen is a thick, viscous crude oil that, at room temperature, is in a near solid state. The definition used in the industry is that crude bitumen is "a naturally occurring viscous mixture, mainly of hydrocarbons heavier than pentane, that may contain sulphur compounds and that, in its naturally occurring viscous state, will not flow to a well".[6]

The term crude bitumen generally refers to petroleum with a density greater than 960 kilograms per cubic meter.[7] In fact, much of the bitumen in Canada's oil sands deposits has densities that exceed 1,000 kg/$m^3$ (API Gravity of less than 10 degrees). Because of its high gravity and high viscosity characteristics, crude bitumen may be blended with a light hydrocarbon liquid (condensate) before it is shipped to markets by pipeline.

Table 2.1 compares the densities of a number of crude oil types, including blended bitumen from Athabasca and Cold Lake.

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[6]Alberta, Canada, *Oil Sands Conservation Act, Section 1(1)(c)*, Alberta Statutes and Regulations. Note that more than 100 thousand b/d (16,000 $m^3$/d) of crude bitumen from the Cold Lake and Athabasca Oil Sands Areas was produced using primary production techniques during 2002, in apparent contravention of this definition.

[7] Alberta Department of Energy, http://www.energy.gov.ab.ca/OilSands/793.asp, February 2008.

**Table 2.1**
**Crude Oil Densities (kg/m3)**

| Crude Oil Type | Density |
|---|---|
| Athabasca Crude Bitumen | 1,015 |
| Cold Lake Crude Bitumen | 1,009 |
| Maya | 921 |
| Athabasca Bitumen Blend | 919[a] |
| Cold Lake Bitumen Blend | 919[a] |
| Bow River Blend | 894 |
| Arab Light | 858 |
| Bonny Light | 841 |
| West Texas Intermediate | 827 |
| Federated Light | 826 |
| Commercial Condensate | 720 |

[a] Athabasca and Cold Lake Bitumen Blends are derived by adding diluent to crude bitumen to reduce viscosity prior to being transported by pipeline. The most commonly used diluent is very light natural gas liquid (C5+ or pentanes plus), which is a by-product of natural gas processing. A condensate diluent typically constitutes 24-32 percent of the bitumen blend.
Sources: (1) *Markets for Canadian Bitumen-Based Feedstock*, CERI Study No. 101; and (2) Alberta Research Council Open File Report 1993-25.

Because of the nature of oil sands, two different methods are used to produce oil from the oil sands – surface mining and in-situ – or producing in place. Currently a majority of the oil derived from oil sands being produced are by surface mining, although only about 20 percent of oil sands are recoverable through this method. This method is used when bitumen is close to the surface.

The remaining 80 percent of resources are recoverable through in-situ technology. This method is employed when the bitumen deposits are further underground. Most in-situ operations use steam-assisted gravity drainage (SAGD). This involves pumping steam underground through a horizontal well to liquefy the bitumen and pump it to the surface. Current investments in advanced technology will make this method of extraction more widely used in the years to come.

## 2.4 Oil Sands Production and Investment Projections

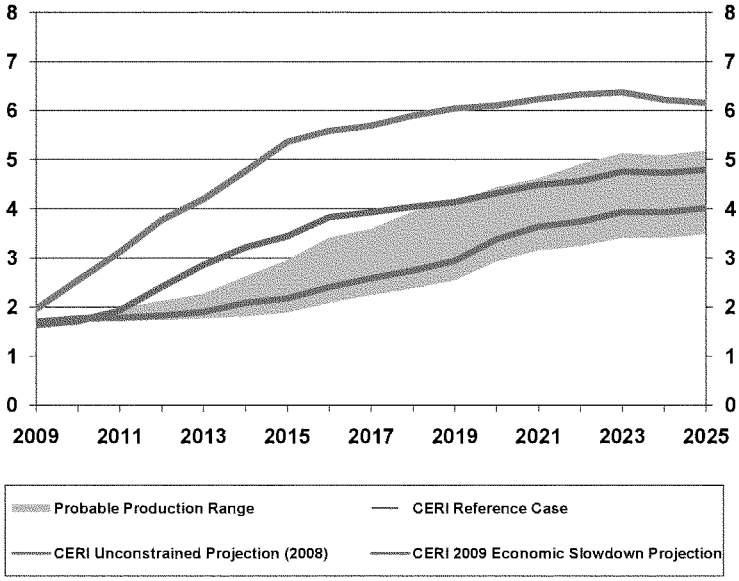
The oil sands production and investment forecast used in this study are based heavily on an oil sands briefing entitled "The Eye of the Beholder: Oil Sands Calamity or Golden Opportunity?" released by CERI in February of this year. In late 2008, CERI released[8] updated oil sands

[8] D. McColl, M. Slagorsky, "Canadian Oil Sands Supply Costs and Development Projects (2008 – 2030)", Study No. 118, November 2008: http://www.ceri.ca/#OilSandsIndustryUpdate, January 29, 2009.

projections.[9] The landscape has, however, dramatically changed since then; these sentiments are shared and reflected in the useful briefing released in February 2009.

Various proponents of oil sands projects have withdrawn their applications, announced delays and/or placed their proposed projects on hold until the economy rebounds and the investment can generate a reasonable rate of return. Figure 2.3 represents CERI's outlook for oil sands production.

**Figure 2.3**
**Bitumen Production Capacity, Million Barrels per Day (MMbpd)**




In 2008, CERI was projecting a potential for oil sands production of over 5 million barrels per day (MMbpd) by 2015, and over 6 MMbpd by 2030. It was our opinion that the likely development path of the oil sands would be far lower than the CERI Unconstrained Projection (2008). The CERI Reference Case Projection (2008) indicated 3.4 MMbpd of bitumen production by 2015, increasing to just under 5 MMbpd by 2025. In the 2008 report, CERI provided a global slowdown case: based upon information available in late October, relating to both the global slowdown and the initial signs of an eventual slowdown in the oil sands. While these data are not presented in

[9] The values that are presented in this briefing reflect the "name plate capacity" for the oil sands and will be higher than actual production. While a facility is built for a certain capacity, it typically doesn't achieve that level of production on a constant basis. There is a litany of reasons why this is the case, and discussing it goes beyond the scope and purpose of the briefing. Actual production values are only slightly under the name plate capacity.

this report, CERI has updated the scenario and it is now presented as the "CERI 2009 Economic Slowdown Projection".

The slowdown projection reflects a scenario in which the price of oil stays below US$60 WTI/bbl for most of 2009 and the credit markets still lack liquidity. Under this projection, economic recovery begins in early 2010, as indicated by the previously provided oil price forecast, and liquidity slowly starts to return to the economy. In conjunction with the economic recovery, oil sands development stalls until 2013, with no major growth until 2015. Previously announced and approved (by government) projects remain delayed, and some remain in peril. This scenario is similar to what is currently taking place in the oil sands industry.

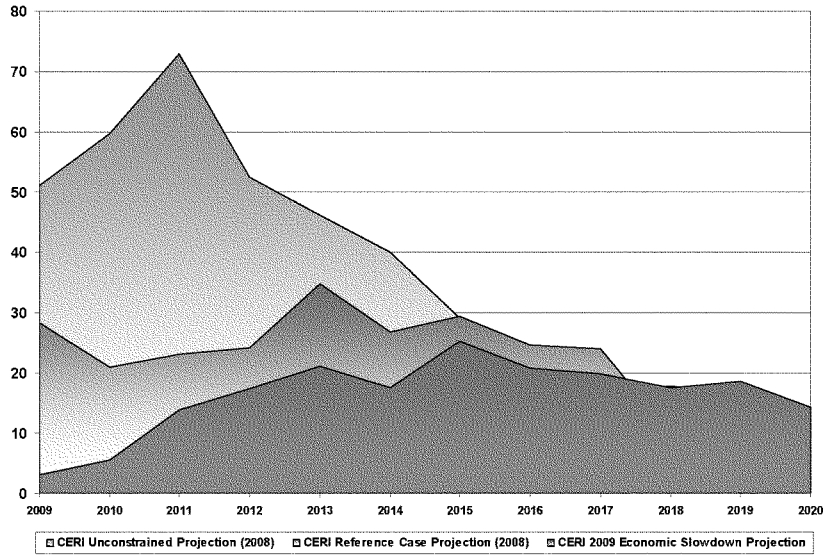
While the price of oil and the global economy are expected to rebound in 2010, it will take another two years before oil sands production growth resumes. CERI assumes this resumption to be limited to established oil sands projects and others with adequate financing in place prior to the credit collapse of 2008; it takes at least two years for most mining and in situ projects to start production after construction begins. However, many projects will not start construction in 2010, but will begin a reassessment and refinancing period that could take several years. Some projects are likely to be deferred until 2015, which will create a further backlog in projects, pushing those with 2015 plans (as announced in 2006 to early 2008) beyond 2020.

While CERI does not anticipate a rapid recovery and explosion in growth, as many had previously projected, we have included a margin of error in our projections, as indicated by the grey area on Figure 2.3. This reflects the Probable Production Range for oil sands development, which is highly dependent upon the recovery in the price of oil and increased liquidity in the capital markets. In 2015 the total production band is 1.9 to 2.9 MMbpd, which broadens by 2025 to 3.5 to 5.1 MMbpd.

Figure 2.4 depicts the total capital expenditure on new oil sands projects (i.e., excluding ongoing or sustaining capital) for the period 2009 to 2020.[10]

[10] Upon request, annual capital spending beyond 2020 is available to organizations that purchase(d) our 2008 report.

**Figure 2.4**
**Oil Sands Capital Investment (2008 $Billions)**




As is apparent, capital spending peaks that were previously projected are not likely to occur over the next 11 years.[11] Oil sands spending will be modest, and at a level that CERI believes the Canadian economy can easily absorb (based upon historic oil sands spending).

The harsh reality is the total "loss" of investment that CERI is estimating. While part of this is a direct result of the economic slowdown, it cannot be solely attributed to the slowdown; there are other factors involved, such as labour and equipment availability. Another way to look at the "loss" is as a gain that is created by the existence and development of the oil sands. The CERI 2009 economic slowdown projection indicates that $218 billion will be invested in the oil sands for new production. This is $97 billion less (the "loss") than previously projected under the CERI reference case projection (2008) and a shocking $241 billion less than the CERI unconstrained projection (2008).

[11] The previous peaks were over $70 billion in 2011 for the CERI Unconstrained Projection (2008), and over $40 billion in 2013 for the CERI Reference Case Projection (2008).

## CHAPTER 3
## IMPACTS ON THE UNITED STATES' ECONOMY

This chapter describes the modeling process (for a more detailed discussion, refer to Appendix B) and impact of Canadian oil sands development on the United States at both the national and state levels. In particular, US economic impacts (industry output, GDP and employment) associated with Canadian oil sands investment and operations are presented.

### 3.1 Overall Modeling Framework

Input/Output (I/O) Analysis was chosen as the most appropriate way to analyze the impact on the US economy of oil sands development. An I/O analysis looks at the relationships between various industries in an economy and how the output of one industry feeds into another industry as an input. This shows us how one industry is dependent upon another for its inputs. For each industry, it displays from which industries its inputs come from and to which industries its output goes.

An I/O analysis lets you examine the impacts that happen to an industry because of the activity in another industry. For example, in this analysis CERI examined the impact that the oil sands development and production has on industries in the US economy by looking at: output (goods and services), GDP, and employment at the national and state levels. Investments in oil sands leads to increased demand, for example, for manufactured goods from Ontario and several US states, including heavy machinery and large trucks. This increase in demand leads to increased demand from other industrial sectors in other Canadian provinces and US states.

Changes in economic variables (e.g., GDP) are the sum of three distinct impacts: direct, indirect, and induced. Of course, there are the *direct* costs and employment associated with development of oil sands consisting for example of geophysical expenditures, drilling, and facilities construction for *In Situ* development. Next, there is a long term effort associated with extraction of the resource. At the end of the field's useful life, there are another set of activities associated with site restoration.

Each of these direct activities generate demands for the goods and services produced in other sectors, such as steel pipe, electricity, transportation, financial services and numerous other sectors. These inter-industry transactions, or *indirect* effects, are captured in the input-output tables published for the United States periodically by the Bureau of Economic Analysis (BEA) of the US Department of Commerce.

Both the direct and indirect activities raise income levels, giving rise to a third set of *induced* effects in response to this increased income. The sectoral breakdown of this activity generally reflects broad patterns of consumer spending based on the Consumer Expenditure Survey data maintained by the Bureau of Labor Statistics (BLS).

A multistage process was used to build the US-Canada Multi-Regional I/O Model (UCMRIO). First, CERI developed a Multi-Regional I/O model for Canada. This model identifies domestic trade flows for Canada covering Canada's 10 provinces and 3 territories based on Statistics Canada data. Next, the US I/O tables, constructed using the I/O tables issued by the Bureau of Economic Analysis (BEA), were connected to the Canadian I/O model, thus creating the UCMRIO. The UCMRIO simulates the trading patterns between each Canadian province and territory with the US economy.

The last step was to take the aggregate impacts on the US economy (national level) reported by the UCMRIO and disaggregate those impacts to the state level. This was done by constructing a series of disaggregating coefficients to allow CERI to depict the economic impacts of Alberta's oil sands developments on each US state.

I/O models, while extremely useful for gaining insight into the linkage between sectors and regions in an economy, have limitations. This is due to three reasons. First, I/O coefficients are based on value relationships between one sector's outputs to other sectors. This could change overtime, thus changing the results. Second, the I/O approach assumes that there are no supply or resources constraints. Third, an I/O model is incapable of representing the feedback mechanism between price change, investment and production. Because of these factors, they are typically used to characterize an economy over a short period of time. In this analysis, a period of 17 years was examined (2009-2025).

### 3.2 Data and Assumptions

As mentioned above, data for the Canada Multi-Regional I/O model came from Statistics Canada. The data for the US I/O model came from the Bureau of Economic Analysis (BEA). Oil prices are assumed to remain at current levels for the next year, eventually rising which results in an average over the analysis of US$100/barrel WTI.[12]

Oil sands production is based upon CERI's Economic Slowdown Projection, an arguably conservative assumption.[13] In this scenario, raw bitumen production exceeds 4.3 million barrels per day (MMBPD) by 2030 and remains constant thereafter (see Figure 2.3). SCO production reaches 2.5 MMBPD by 2030 and remains constant thereafter. In this scenario, oil sands development is curtailed from its potential (unconstrained) development by various factors: oil prices, resources, regulatory. However, it is assumed that there are no barriers to entry into the US.

Based on the capital costs in Table 3.1, the investment required to meet the production forecast in the Economic Slowdown Projection is $218 billion (US$). In the peak year of investment (2015), approximately $25 billion in new investment is required and $7 billion in operating costs (see Figure 3.1).

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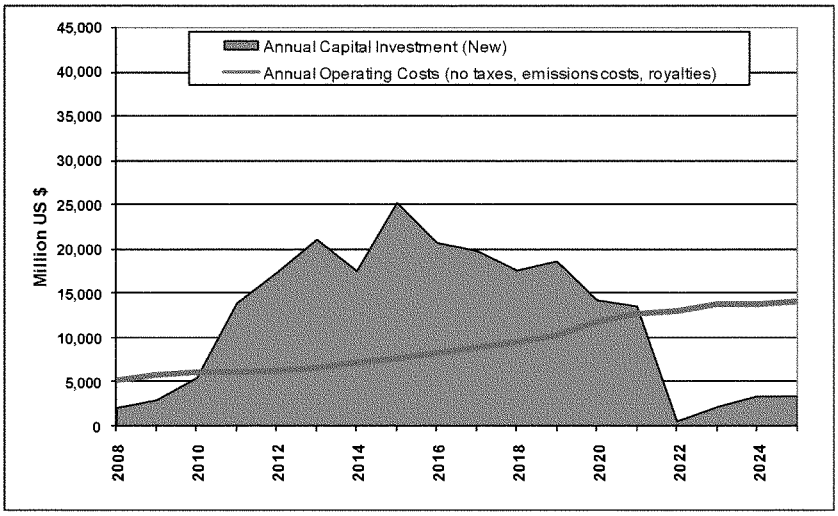
[12] Expressed as an annual average price of CERI's long range oil price forecast (real dollars) over the next 25 years.
[13] http://www.ceri.ca/Publications/documents/CERIOilSandsBriefingFebruary2009.pdf

**Table 3.1**
**Capital Costs[14] (based upon late 2008 estimates expressed in US$/barrel of capacity)**

| | |
|---|---|
| In situ | US$29,000 |
| Mining and Extraction | US$90,000 |
| Stand-alone upgrading | US$58,000 |
| Integrated Mining and Extraction and Upgrading | US$127,000 |

**Figure 3.1**
**Investment Required to Meet Production Scenario**




Source: www.ceri.ca/Publications/documents/CERIOilSandsBriefingFebruary2009.pdf

It is important to note that investment and operation expenditures are initially determined on a project basis, totaled and allocated to the production type level (i.e. mining and extraction, In Situ, integrated mining, extraction and upgrading and stand alone upgrader). These dollars are used in the model to "shock" the Alberta economy in various sectors (coincident shocks) including the Oil Sands, the Construction, the Refinery, and the Manufacturing sectors. These shocks are considered at the field plant outlet, or to the upgrader outlet for a stand alone upgrader, and include bitumen and SCO products. The relationship between the Oil Sands industry and the Pipeline and Refining industries is captured in the base economy and thus shocks on the supply side results in impacts on these and other industries. The US sectors are

[14] Capital costs derived from publicly announced project estimates and local market participants and where necessary inflated to 2008 dollars utilizing the Nelson-Farrar Refinery Cost Index. Refer to the CERI report "Canadian Oil Sands Supply Costs and Development Projects (2008-2030)" November 2008

represented in the model as the 14th segment (10 Canadian provinces + 3 territories + US). Investment shocks in Alberta result in impacts to the US economy at the sector level. The BEA data is used to link these shocks on the US sectors to the US state and US industry levels. Thus refinery upgrades to handle oil sand crudes are not directly handled by the model but generic refiner upgrades would be associated with the indirect impact relationship between the investment shocks and the refinery sector (both in Canada and the US). In other words, investment and operating dollar shocks are only done to Alberta industries; no direct shocks are made to the US sectors. Hence, the economic impacts reported herein do not capture the direct investments in US refineries that may be undertaken to process increased crude oil from Canada.

### 3.3 Results

Canada and the US are major trading partners, and the results clearly show significant economic benefits to the US from increased economic activity in Canada. As investment and production ramps up in Canada, the pace of economic activity quickens and demand for US goods and services increase rapidly, resulting in an estimated 343 thousand new US jobs between 2011 and 2015. Demand for US goods and services continues to climb annually throughout the period, adding an estimated $34 billion to US GDP in 2015, $40.4 billion in 2020, and $42.2 billion in 2025. As explained earlier, these are the sum of direct, indirect and induced impacts.

**Table 3.2**
**Impact on US Output, GDP, and Employment**

| National Impacts ($US Billion) | 2010 | 2015 | 2020 | 2025 |
|---|---|---|---|---|
| U.S. Output | 23.0 | 69.2 | 78.5 | 80.9 |
| U.S. Gross Domestic Product | 11.5 | 34.0 | 40.4 | 42.2 |

| National Impacts (Thousand Person Year) | 2009-2010 | 2011-2015 | 2016-2020 | 2021-2025 |
|---|---|---|---|---|
| U.S. Employment | 172 | 343 | 88 | 22 |

"Thousand Person Year" equates to the number of jobs created, times 1,000, for a given year and for as long as the project operates. With regards to the table above, the number of jobs listed indicates the number of incremental jobs that are created. For example, between 2011 and 2015 an incremental 343 thousand jobs are created.

The economic benefits of oil sands development and production do not fall to one industry but are broadly shared across many industrial sectors. Table 3.3 shows the increase in output of goods and services from various US industrial sectors due to the development and production of Canadian oil sands. On average, US output of goods and services increases by $62 billion per year over the period of analysis, 2009- 2025. Although all US economic sectors gain in output, "Other manufacturing" has the greatest increase in output, followed by "Finance, Insurance, and Real Estate". [15] An example of the increase in "Other Manufacturing", is the increased production of heavy trucks in the US that are used to transport the oil-bearing sand. The mines in Alberta's Wood Buffalo region are the largest surface mines in the world, with equipment sized to match. Steel products that would generally be manufactured in western Canada from scrap steel include casing, tubing and other welded pipe; I-beams, tubular beams and other simple structural components. More sophisticated and metallurgically-altered steel products would be imported from the United States (primarily the upper Midwest) and overseas, or else manufactured in Ontario from steel produced in Ontario using metallurgical coal imported from the United States (primarily Appalachia). Some of the manufactured products that are likely to be sourced in the upper Midwest include trucks, shovels, dump hoppers, conveyer equipment, pumping equipment, tanks, and some boilers and chemicals.

[15] The increase in US sectoral output due to Canadian oil sands development increases the demand for oil and natural gas. It was beyond the scope of this study to determine the share of the increased oil and natural gas demand that would be met from increased domestic production, and hence oil and natural gas sector results are not available.

**Table 3.3**
**Change in US Output by Industry**

| Change in Output by Industry ($US Million) | 2010 | 2015 | 2020 | 2025 | Annual Average |
|---|---|---|---|---|---|
| Forestry, fishing, agriculture and other activities | 494 | 1,598 | 1,517 | 1,414 | 1,253 |
| Mining, except oil and gas | 230 | 655 | 848 | 921 | 643 |
| Support activities for mining | 372 | 1,061 | 1,373 | 1,492 | 1,041 |
| Utilities | 429 | 1,259 | 1,514 | 1,601 | 1,171 |
| Construction | 320 | 940 | 1,147 | 1,212 | 881 |
| Refinery | 1,026 | 3,021 | 1,411 | 1,467 | 1,878 |
| Petrochemical | 721 | 2,191 | 2,452 | 2,495 | 1,929 |
| Other Manufacturing | 5,693 | 18,396 | 18,644 | 17,533 | 14,925 |
| Wholesale Trade | 1,118 | 3,432 | 3,709 | 3,728 | 2,953 |
| Retail Trade | 947 | 2,794 | 3,383 | 3,559 | 2,602 |
| Transportation and Warehousing | 867 | 2,581 | 2,967 | 3,090 | 2,328 |
| Information and Cultural Industries | 993 | 2,939 | 3,538 | 3,713 | 2,725 |
| Finance, Insurance, Real Estate and Rental and Leasing | 5,082 | 14,412 | 19,064 | 20,825 | 14,351 |
| Professional, Scientific and Technical Services | 1,521 | 4,444 | 5,507 | 5,853 | 4,211 |
| Administrative and Support, Waste Management and Remediation Services | 970 | 2,848 | 3,483 | 3,684 | 2,673 |
| Educational Services | 97 | 289 | 342 | 358 | 265 |
| Health Care and Social Assistance | 164 | 482 | 586 | 619 | 451 |
| Arts, Entertainment and Recreation | 245 | 722 | 877 | 924 | 674 |
| Accommodation and Food Services | 793 | 2,317 | 2,870 | 3,052 | 2,196 |
| Other Services and Non-Profit organisations | 761 | 2,293 | 2,625 | 2,699 | 2,052 |
| Government Sector | 170 | 500 | 606 | 639 | 466 |
| Total | 23,012 | 69,173 | 78,463 | 80,876 | 61,668 |

"Annual Average" equates to the total increase in output over the 17 year forecast divided by 17 years.

Table 3.4 tells a similar story but with regard to various sectors' contribution to the increase in GDP. The difference between the two measures, output and GDP is due to the standard procedure followed in estimating national accounts. GDP accounts only for value added during the production processes and excludes intermediate goods, which are produced not for final consumption but for use as inputs in the production of other goods and services.

**Table 3.4**
**Change in US GDP by Industry**

| Change in Value Added by Industry (GDP) $US Million | 2010 | 2015 | 2020 | 2025 | Annual Average |
|---|---|---|---|---|---|
| Forestry, fishing, agriculture and other activities | 185 | 597 | 567 | 529 | 469 |
| Mining, except oil and gas | 121 | 345 | 447 | 486 | 339 |
| Support activities for mining | 174 | 495 | 641 | 697 | 486 |
| Utilities | 258 | 758 | 912 | 964 | 705 |
| Construction | 160 | 471 | 575 | 607 | 441 |
| Refinery | 150 | 442 | 206 | 215 | 275 |
| Petrochemical | 212 | 646 | 723 | 736 | 569 |
| Other Manufacturing | 1,560 | 5,040 | 5,108 | 4,803 | 4,089 |
| Wholesale Trade | 836 | 2,567 | 2,775 | 2,789 | 2,209 |
| Retail Trade | 652 | 1,925 | 2,331 | 2,452 | 1,793 |
| Transportation and Warehousing | 450 | 1,340 | 1,540 | 1,603 | 1,208 |
| Information and Cultural Industries | 462 | 1,369 | 1,648 | 1,729 | 1,269 |
| Finance, Insurance, Real Estate and Rental and Leasing | 3,398 | 9,636 | 12,745 | 13,923 | 9,595 |
| Professional, Scientific and Technical Services | 931 | 2,721 | 3,372 | 3,584 | 2,579 |
| Administrative and Support, Waste Management and Remediation Services | 658 | 1,931 | 2,361 | 2,497 | 1,812 |
| Educational Services | 58 | 172 | 204 | 213 | 158 |
| Health Care and Social Assistance | 102 | 299 | 364 | 385 | 280 |
| Arts, Entertainment and Recreation | 154 | 455 | 553 | 583 | 425 |
| Accommodation and Food Services | 408 | 1,192 | 1,476 | 1,570 | 1,129 |
| Other Services and Non-Profit organisations | 414 | 1,246 | 1,429 | 1,469 | 1,116 |
| Government Sector | 107 | 316 | 382 | 404 | 295 |
| Total | 11,451 | 33,963 | 40,359 | 42,237 | 31,240 |

"Annual Average" equates to the total increase in output over the 17 year forecast divided by 17 years.

Table 3.5 shows changes in sectoral employment in the US due to development and production of Canadian oil sands. The table shows the number of new jobs created. For example, between 2011 and 2015, an additional 57.7 thousand jobs are estimated to be created in "Other Manufacturing". Building on the earlier example, a portion of the increase in demand for workers in "Other Manufacturing" represents the need for workers to build the heavy trucks and other equipment imported into Canada from the US for use in the production and processing of the oil sands. As the capital investment tapers off between 2021 and 2025, the need for new jobs diminishes and the sector loses 5 thousand of the 85 thousand jobs that had been created since 2009 for a net gain in employment in the sector of 80 thousand over the life of the project This is because CERI projections of oil sands investment are based on actual project announcements and these do not go beyond 2025.

**Table 3.5**
**Change in US Employment by Industry**

| Employment by Industry (Thousand Person Year) | 2009-2010 | 2011-2015 | 2016-2020 | 2021-2025 |
|---|---|---|---|---|
| Forestry, fishing, agriculture and other activities | 7.3 | 16.3 | (1.2) | (1.5) |
| Mining, except oil and gas | 1.3 | 2.4 | 1.1 | 0.4 |
| Support activities for mining | 1.9 | 3.4 | 1.6 | 0.6 |
| Utilities | 0.7 | 1.4 | 0.4 | 0.1 |
| Construction | 4.0 | 7.8 | 2.6 | 0.8 |
| Refinery | 0.6 | 1.1 | (0.9) | 0.0 |
| Petrochemical | 1.4 | 2.9 | 0.5 | 0.1 |
| Other Manufacturing | 25.8 | 57.7 | 1.1 | (5.0) |
| Wholesale Trade | 9.8 | 20.2 | 2.4 | 0.2 |
| Retail Trade | 19.2 | 37.4 | 11.9 | 3.6 |
| Transportation and Warehousing | 6.7 | 13.2 | 3.0 | 0.9 |
| Information and Cultural Industries | 4.1 | 8.0 | 2.5 | 0.7 |
| Finance, Insurance, Real Estate and Rental and Leasing | 23.8 | 43.7 | 21.8 | 8.2 |
| Professional, Scientific and Technical Services | 11.3 | 21.7 | 7.9 | 2.6 |
| Administrative and Support, Waste Management and Remediation Services | 11.3 | 21.9 | 7.4 | 2.3 |
| Educational Services | 2.2 | 4.3 | 1.2 | 0.3 |
| Health Care and Social Assistance | 2.9 | 5.5 | 1.8 | 0.6 |
| Arts, Entertainment and Recreation | 6.0 | 11.7 | 3.8 | 1.2 |
| Accommodation and Food Services | 15.1 | 29.0 | 10.5 | 3.5 |
| Other Services and Non-Profit organisations | 14.7 | 29.3 | 7.2 | 1.7 |
| Government Sector | 2.0 | 3.8 | 1.2 | 0.4 |
| Total | 171.9 | 342.7 | 87.8 | 21.7 |

Note: "Thousand Person Year" equates to the number of jobs created, times 1,000, for a given year and for as long as the project operates. With regards to the table above, the number of jobs listed indicates the number of **incremental** jobs that have been created. For example, between 2011 and 2015 an incremental 343 thousand jobs have been created, 57.7 thousand of which are estimated to be created in "Other Manufacturing". These jobs are the sum of direct, indirect and induced employment impacts.

Just as the benefits of Canadian oil sands development and production do not fall solely to one US economic sector, nor do they fall to just one region of the country. Table 3.6 shows that industrial output increases around the country. For example, the increase in industry output in Michigan ($2 billion in 2015) captures the increased production of heavy trucks for oil sands development along with other goods and services. Similarly, Table 3.7 shows the change in GDP by state.

**Table 3.6: Change in Industry Output by State**

| Change in Industry Output by State ($US Million) | 2010 | 2015 | 2020 | 2025 | Annual Average |
|---|---|---|---|---|---|
| Alabama | 275 | 837 | 936 | 950 | 736 |
| Alaska | 58 | 169 | 200 | 211 | 156 |
| Arizona | 404 | 1,210 | 1,421 | 1,470 | 1,100 |
| Arkansas | 159 | 486 | 544 | 550 | 427 |
| California | 3,228 | 9,691 | 10,755 | 11,092 | 8,545 |
| Colorado | 374 | 1,114 | 1,306 | 1,359 | 1,015 |
| Connecticut | 340 | 1,014 | 1,200 | 1,246 | 928 |
| Delaware | 102 | 299 | 356 | 376 | 277 |
| District of Columbia | 98 | 286 | 353 | 374 | 270 |
| Florida | 1,062 | 3,151 | 3,763 | 3,938 | 2,906 |
| Georgia | 605 | 1,821 | 2,110 | 2,174 | 1,641 |
| Hawaii | 77 | 227 | 273 | 289 | 211 |
| Idaho | 95 | 289 | 325 | 329 | 255 |
| Illinois | 1,027 | 3,083 | 3,544 | 3,658 | 2,769 |
| Indiana | 487 | 1,494 | 1,638 | 1,649 | 1,295 |
| Iowa | 234 | 719 | 800 | 806 | 629 |
| Kansas | 198 | 601 | 661 | 673 | 525 |
| Kentucky | 274 | 835 | 925 | 937 | 730 |
| Louisiana | 535 | 1,583 | 1,375 | 1,433 | 1,246 |
| Maine | 69 | 208 | 241 | 247 | 187 |
| Maryland | 353 | 1,049 | 1,251 | 1,308 | 966 |
| Massachusetts | 593 | 1,784 | 2,084 | 2,149 | 1,615 |
| Michigan | 679 | 2,069 | 2,319 | 2,355 | 1,821 |
| Minnesota | 442 | 1,337 | 1,497 | 1,533 | 1,181 |
| Mississippi | 153 | 464 | 493 | 503 | 399 |
| Missouri | 362 | 1,096 | 1,255 | 1,286 | 979 |
| Montana | 52 | 155 | 178 | 186 | 140 |
| Nebraska | 128 | 389 | 439 | 447 | 344 |
| Nevada | 199 | 585 | 713 | 753 | 548 |
| New Hampshire | 94 | 283 | 328 | 337 | 255 |
| New Jersey | 708 | 2,103 | 2,480 | 2,591 | 1,925 |
| New Mexico | 130 | 393 | 441 | 451 | 347 |
| New York | 1,703 | 5,015 | 6,101 | 6,433 | 4,687 |
| North Carolina | 698 | 2,130 | 2,410 | 2,444 | 1,883 |
| North Dakota | 47 | 144 | 159 | 162 | 126 |
| Ohio | 807 | 2,454 | 2,733 | 2,779 | 2,154 |
| Oklahoma | 228 | 683 | 755 | 782 | 602 |
| Oregon | 394 | 1,228 | 1,336 | 1,321 | 1,053 |
| Pennsylvania | 848 | 2,552 | 2,921 | 3,009 | 2,285 |
| Rhode Island | 67 | 201 | 238 | 248 | 184 |
| South Carolina | 238 | 724 | 823 | 837 | 642 |
| South Dakota | 57 | 173 | 197 | 201 | 154 |
| Tennessee | 415 | 1,263 | 1,428 | 1,452 | 1,118 |
| Texas | 2,087 | 6,275 | 6,834 | 7,033 | 5,475 |
| Utah | 177 | 530 | 605 | 626 | 475 |
| Vermont | 42 | 127 | 145 | 147 | 113 |
| Virginia | 555 | 1,659 | 1,955 | 2,028 | 1,513 |
| Washington | 486 | 1,462 | 1,651 | 1,700 | 1,300 |
| West Virginia | 93 | 276 | 324 | 339 | 252 |
| Wisconsin | 418 | 1,282 | 1,438 | 1,451 | 1,126 |
| Wyoming | 58 | 169 | 206 | 219 | 159 |
| Total US | 23,012 | 69,173 | 78,463 | 80,876 | 61,668 |

**Table 3.7: Change in State GDP ("Value-Added")**

| Value Added by State (GSP) $US Million | 2010 | 2015 | 2020 | 2025 | Annual Average |
|---|---|---|---|---|---|
| Alabama | 128 | 384 | 448 | 464 | 348 |
| Alaska | 30 | 87 | 106 | 113 | 82 |
| Arizona | 213 | 629 | 759 | 797 | 584 |
| Arkansas | 74 | 224 | 259 | 267 | 201 |
| California | 1,576 | 4,672 | 5,523 | 5,783 | 4,287 |
| Colorado | 198 | 583 | 704 | 740 | 542 |
| Connecticut | 181 | 533 | 648 | 683 | 498 |
| Delaware | 57 | 165 | 205 | 219 | 157 |
| District of Columbia | 59 | 171 | 212 | 225 | 162 |
| Florida | 604 | 1,776 | 2,164 | 2,285 | 1,663 |
| Georgia | 316 | 938 | 1,117 | 1,167 | 863 |
| Hawaii | 45 | 131 | 161 | 171 | 124 |
| Idaho | 45 | 135 | 157 | 162 | 122 |
| Illinois | 529 | 1,567 | 1,871 | 1,960 | 1,445 |
| Indiana | 210 | 635 | 729 | 749 | 569 |
| Iowa | 107 | 322 | 371 | 382 | 289 |
| Kansas | 92 | 275 | 319 | 331 | 249 |
| Kentucky | 124 | 373 | 432 | 446 | 336 |
| Louisiana | 183 | 540 | 576 | 606 | 471 |
| Maine | 36 | 106 | 127 | 133 | 98 |
| Maryland | 197 | 580 | 706 | 746 | 543 |
| Massachusetts | 307 | 910 | 1,096 | 1,149 | 844 |
| Michigan | 320 | 960 | 1,124 | 1,164 | 872 |
| Minnesota | 216 | 644 | 758 | 789 | 588 |
| Mississippi | 68 | 202 | 232 | 241 | 182 |
| Missouri | 182 | 542 | 640 | 666 | 496 |
| Montana | 27 | 81 | 97 | 102 | 75 |
| Nebraska | 63 | 189 | 220 | 228 | 171 |
| Nevada | 113 | 330 | 407 | 432 | 312 |
| New Hampshire | 48 | 144 | 172 | 180 | 133 |
| New Jersey | 387 | 1,140 | 1,381 | 1,456 | 1,063 |
| New Mexico | 60 | 179 | 211 | 220 | 164 |
| New York | 978 | 2,856 | 3,540 | 3,766 | 2,708 |
| North Carolina | 324 | 971 | 1,139 | 1,179 | 883 |
| North Dakota | 23 | 68 | 78 | 81 | 61 |
| Ohio | 379 | 1,135 | 1,327 | 1,375 | 1,031 |
| Oklahoma | 107 | 317 | 373 | 391 | 290 |
| Oregon | 162 | 493 | 558 | 566 | 436 |
| Pennsylvania | 428 | 1,271 | 1,512 | 1,582 | 1,170 |
| Rhode Island | 36 | 107 | 131 | 138 | 101 |
| South Carolina | 115 | 345 | 406 | 421 | 314 |
| South Dakota | 29 | 86 | 102 | 106 | 79 |
| Tennessee | 200 | 598 | 701 | 726 | 544 |
| Texas | 954 | 2,835 | 3,304 | 3,447 | 2,577 |
| Utah | 89 | 262 | 314 | 329 | 242 |
| Vermont | 20 | 60 | 71 | 74 | 55 |
| Virginia | 296 | 876 | 1,058 | 1,112 | 815 |
| Washington | 245 | 728 | 862 | 901 | 668 |
| West Virginia | 47 | 139 | 168 | 177 | 129 |
| Wisconsin | 192 | 579 | 674 | 695 | 523 |
| Wyoming | 30 | 87 | 108 | 116 | 83 |
| Total US | 11,451 | 33,963 | 40,359 | 42,237 | 31,240 |

Employment increases across the county with some of the largest impacts occurring in California (43 thousand jobs created between 2011 and 2015), Florida (20 thousand jobs created between 2011 and 2015), and Texas (27 thousand jobs created between 2011 and 2015). These US jobs are created by the indirect and induced impacts of Canadian oil sands development and production.

**Table 3.8 Change in State Employment.**

| Incremental Employment by State Thousand Person Year | 2009-2010 | 2011-2015 | 2016-2020 | 2021-2025 |
|---|---|---|---|---|
| Alabama | 2.6 | 5.2 | 1.1 | 0.2 |
| Alaska | 0.5 | 0.9 | 0.2 | 0.1 |
| Arizona | 3.3 | 6.5 | 1.9 | 0.5 |
| Arkansas | 1.6 | 3.2 | 0.7 | 0.1 |
| California | 21.6 | 43.2 | 10.6 | 2.5 |
| Colorado | 3.0 | 6.0 | 1.7 | 0.5 |
| Connecticut | 2.0 | 4.0 | 1.1 | 0.3 |
| Delaware | 0.5 | 1.0 | 0.3 | 0.1 |
| District of Columbia | 0.6 | 1.2 | 0.3 | 0.1 |
| Florida | 10.3 | 20.3 | 5.6 | 1.5 |
| Georgia | 5.3 | 10.5 | 2.7 | 0.7 |
| Hawaii | 0.7 | 1.4 | 0.4 | 0.1 |
| Idaho | 0.9 | 1.9 | 0.4 | 0.1 |
| Illinois | 7.3 | 14.6 | 3.7 | 0.9 |
| Indiana | 3.7 | 7.6 | 1.6 | 0.3 |
| Iowa | 1.9 | 3.9 | 0.9 | 0.2 |
| Kansas | 1.6 | 3.2 | 0.8 | 0.2 |
| Kentucky | 2.4 | 4.8 | 1.1 | 0.2 |
| Louisiana | 2.4 | 4.8 | 1.2 | 0.4 |
| Maine | 0.8 | 1.7 | 0.3 | 0.1 |
| Maryland | 2.9 | 5.7 | 1.7 | 0.5 |
| Massachusetts | 3.9 | 7.7 | 2.1 | 0.5 |
| Michigan | 5.3 | 10.6 | 2.5 | 0.5 |
| Minnesota | 3.4 | 6.8 | 1.6 | 0.4 |
| Missouri | 1.5 | 2.9 | 0.6 | 0.1 |
| Montana | 0.6 | 1.2 | 0.3 | 0.1 |
| Nebraska | 1.1 | 2.3 | 0.6 | 0.1 |
| Nevada | 1.7 | 3.2 | 1.1 | 0.3 |
| New Hampshire | 0.8 | 1.6 | 0.4 | 0.1 |
| New Jersey | 4.7 | 9.3 | 2.6 | 0.7 |
| New Mexico | 1.0 | 2.0 | 0.6 | 0.2 |
| New York | 9.8 | 19.4 | 5.6 | 1.5 |
| North Carolina | 5.1 | 10.3 | 2.5 | 0.5 |
| North Dakota | 0.4 | 0.8 | 0.2 | 0.1 |
| Ohio | 6.5 | 13.2 | 3.1 | 0.7 |
| Oklahoma | 2.0 | 4.0 | 1.0 | 0.3 |
| Oregon | 2.3 | 4.7 | 1.0 | 0.2 |
| Pennsylvania | 6.9 | 13.8 | 3.4 | 0.8 |
| Rhode Island | 0.5 | 1.1 | 0.3 | 0.1 |
| South Carolina | 2.3 | 4.7 | 1.2 | 0.3 |
| South Dakota | 0.5 | 1.0 | 0.2 | 0.1 |
| Tennessee | 3.5 | 7.0 | 1.8 | 0.4 |
| Texas | 13.8 | 27.3 | 7.2 | 1.9 |
| Utah | 1.6 | 3.1 | 0.9 | 0.2 |
| Vermont | 0.4 | 0.8 | 0.2 | 0.0 |
| Virginia | 4.3 | 8.4 | 2.4 | 0.6 |
| Washington | 3.7 | 7.3 | 1.8 | 0.4 |
| West Virginia | 0.9 | 1.7 | 0.5 | 0.1 |
| Wisconsin | 3.5 | 7.2 | 1.6 | 0.3 |
| Wyoming | 0.4 | 0.8 | 0.3 | 0.1 |
| Total US | 171.9 | 342.7 | 87.8 | 21.7 |

### 3.4 Conclusion

Developing the Canadian oil sands is a very capital intensive endeavor, requiring billions of dollars of investment over the next several decades. This investment would give rise to a long-lived, robust period of increased economic activity in Canada. Due to the deep and rich trading relationship between Canada and the United States, the US derives significant economic benefits from this increased economic activity across many sectors throughout the United States. The benefits manifest themselves in terms of increased economic output, GDP and job creation. In addition, the US benefits from a stable supply of oil, something not considered by the report but critically important to US energy security.

## APPENDIX A
## CRUDE BITUMEN RESERVES

This appendix discusses crude bitumen reserves and is divided into two parts: crude bitumen reserves and mineable crude bitumen reserves.

### A.1 Crude Bitumen Reserves

The Alberta Energy and Utilities Board (EUB) estimates the initial volume of crude bitumen in-place to be 270.3 billion $m^3$ (1,701 billion barrels) as of December 31, 2006. The Athabasca region alone accounts for almost 80 percent or 217.7 billion $m^3$ (1,369 billion barrels) of the total.

Table A.1 summarizes the volumetric resources by oil sands area (OSAs) and oil sands deposit (OSDs). OSAs define the geographical boundaries of crude bitumen occurrence, while OSDs contain the specific geological zones declared as oil sands deposits. Both, OSAs and OSDs are designated by the ERCB.

**Table A.1**
**Initial In-Place Volumes of Crude Bitumen**

| Oil Sands Area<br>Oil Sands Deposit | Initial Volume In-Place ($10^6m^3$) | Average Pay Thickness (m) | Average Bitumen Saturation (%) | | |
|---|---|---|---|---|---|
| | | | Mass | Pore Volume | Average Porosity |
| **Athabasca** | | | | | |
| Grand Rapids | 8,678 | 7.2 | 6.3 | 56 | 30 |
| Wabiskaw-McMurray (mineable) | 16,087 | 30.5 | 9.7 | 69 | 30 |
| Wabiskaw-McMurray (in situ) | 132,128 | 13.2 | 10.2 | 73 | 29 |
| Nisku | 10,330 | 8.0 | 5.7 | 63 | 21 |
| Grosmont | 50,500 | 10.4 | 4.7 | 68 | 16 |
| Sub-Total | 217,723 | | | | |
| **Cold Lake** | | | | | |
| Grand Rapids | 17,304 | 5.9 | 9.5 | 66 | 31 |
| Clearwater | 9,422 | 11.8 | 8.9 | 59 | 31 |
| Wabiskaw-McMurray | 4,287 | 5.4 | 7.3 | 59 | 27 |
| Sub-Total | 31,013 | | | | |
| **Peace River** | | | | | |
| Bluesky-Gething | 10,968 | 6.1 | 8.1 | 68 | 26 |
| Belloy | 282 | 8.0 | 7.8 | 64 | 27 |
| Debolt | 7,800 | 23.7 | 5.1 | 65 | 18 |
| Shunda | 2,510 | 14.0 | 5.3 | 52 | 23 |
| Sub-Total | 21,560 | | | | |
| **Total** | 270,296 | | | | |

SOURCE: Alberta Energy and Utilities Board, Alberta's Energy Reserves 2006 and Supply/Demand Outlook 2007 – 2016, June 2007, http://www.eub.gov.ab.ca/bbs/products/STs/st98_current.pdf.

As of December 31, 2008, remaining established reserves were estimated by the EUB to be 27.07 billion $m^3$ (170.4 billion barrels). Remaining established reserves are calculated separately for those that are likely to be recovered by mining methods and those by in situ methods using established technology and under anticipated economic conditions.

Bitumen from the shallower oil sands deposits is extracted through open-pit mining operations. These mines expose the oil sands by stripping the overburden. The oil sand is then removed by using truck and shovel mining methods. Bitumen is separated from the sand through a process of adding warm water and agitation. Roughly two tons of sand are mined, moved and processed to produce one barrel of bitumen.

In situ, on the other hand, means "in-place", and indicates that the bitumen is extracted from the sand in the reservoir. These techniques are employed for deeper oil sands deposits (generally greater than about 75m to the top of the oil sands formation). The two main in situ processes currently being used are cyclic steam stimulation (CSS) and steam-assisted gravity drainage (SAGD). These methods inject steam into the formation to heat the bitumen, allowing it to flow and be pumped to the surface.

The EUB determined mineable established reserves by identifying potential mineable areas using economic strip ratio (ESR) criteria, a minimum saturation cutoff of 7 weight percent, and a minimum saturated zone thickness cutoff of 3.0 metres. The ESR criteria are fully explained in *ERCB Report 79-H, Appendix 3.*[16]

The EUB determined in situ established reserves for those areas considered amenable to in situ recovery methods. Reserves attributable to thermal development were determined using a minimum saturation cutoff of three weight percent crude bitumen and a minimum zone thickness of ten metres. For primary development, the same saturation cutoff of three weight percent was used, with a minimum zone thickness of three metres. Recovery factors of twenty percent for thermal development and five percent for primary development were applied to the areas within the cutoffs. The recovery factor for future thermal development is assumed to be lower than recoveries being achieved by some of the active in situ projects. This is to account for the uncertainty in the future recovery processes and the uncertainties inherent with developing poorer quality resource areas (areas under active development are of higher quality than future areas). While the resource base is very large, it is worth noting that many in situ recovery technologies are still in the early development stage and there is still considerable uncertainty about how much crude bitumen will ultimately be recovered.

[15]Alberta Canada, Alberta Energy Resources Conservation Board, *Alsands Fort McMurray Project, ERCB Report 79-H,* 1979.

Table B.2 summarizes the EUB's estimates of in-place volumes and established mineable and in situ crude bitumen reserves.[17]

**Table A.2**
**In-Place Volumes and Established Reserves of Crude Bitumen**
($10^9 m^3$ as of December 31, 2006)

| Recovery Method | Initial Volume In-Place | Initial Established Reserves | Cumulative Production | Remaining Established Reserves | Remaining Established Reserves Under Active Development |
|---|---|---|---|---|---|
| Mineable | 16.1 | 5.59 | 0.58 | 5.01 | 2.95 |
| In situ | 254.2 | 22.80 | 0.28 | 22.53 | 0.39 |
| Total | 270.3 | 28.39 | 0.86 | 27.53 | 3.34 |
| | (1,701)[a] | (178.7)[a] | (5.4)[a] | (173.2)[a] | (21.0)[a] |

[a] Imperial equivalent in billions of stock-tank barrels.
Source: Alberta Energy and Utilities Board, *Statistical Series 2007-98, Alberta's Energy Reserves 2006 and Supply/Demand Outlook 2007-2016.*

Of the remaining established reserves of 27.53 billion $m^3$, 3.34 billion $m^3$ (21.0 billion barrels), or 12.13 percent, were under active development at year-end 2006. Significantly, more than 80 percent of remaining established reserves are estimated to be recoverable from in situ techniques.[18]

### A.2 Mineable Crude Bitumen Reserves (under active development)

Oil sands mines currently comprise operations by Suncor Energy Inc., Syncrude Canada Ltd. and Albian Sands Energy Inc. The first commercial development of Alberta's oil sands began when Great Canadian Oil Sands (now Suncor) opened its mine, extraction plant and upgrader north of Fort McMurray in 1967. This was followed by development of the Syncrude mine, extraction plant and upgrader, in the same area, in the 1970s. Construction began on the Syncrude site in 1973 and, after five years of construction, Syncrude commenced production in 1978. Albian Sands operates the Muskeg River Mine located 75 kilometers north of Fort McMurray. The project reached a major milestone with start-up and first bitumen production on December 29, 2002. Albian Sands is part of the Athabasca Oil Sands Project (AOSP), a joint venture between Shell Canada Limited (60 percent), Chevron Canada Limited (20 percent) and Marathon Oil Canada Corporation (20 percent).

The EUB publishes estimates of mineable crude bitumen reserves for each of the three operators as shown in Table B.3.

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[17] Alberta, Canada, Alberta Energy and Utilities Board, *EUB Statistical Series 2007-98: Alberta's Reserves 2006 and Supply Demand Outlook 2007-2016* (Calgary, Alberta, 2007), http://www.eub.gov.ab.ca/bbs/products/STs/st98_current.pdf.
[18] Ibid.

**Table A.3**
**Mineable Crude Bitumen Reserves**
($10^6m^3$ as of December 31, 2006)

| Development | Initial Volume In-Place | Initial Established Reserves | Cumulative Production | Remaining Established Reserves |
|---|---|---|---|---|
| Albian Sands | 672 | 419 | 32 | 387 |
| Fort Hills | 699 | 364 | 0 | 364 |
| Horizon | 834 | 537 | 0 | 537 |
| Jackpine | 361 | 222 | 0 | 222 |
| Suncor | 990 | 687 | 220 | 467 |
| Syncrude | 2,071 | 1,306 | 330 | 976 |
| Total | 5,627 | 3,535 | 582 | 2,953 |

Source: Alberta Energy and Utilities Board, Statistical Series 2007-98, Alberta's Energy Reserves 2006 and Supply/Demand Outlook 2007-2016.

## APPENDIX B
## METHODOLOGY

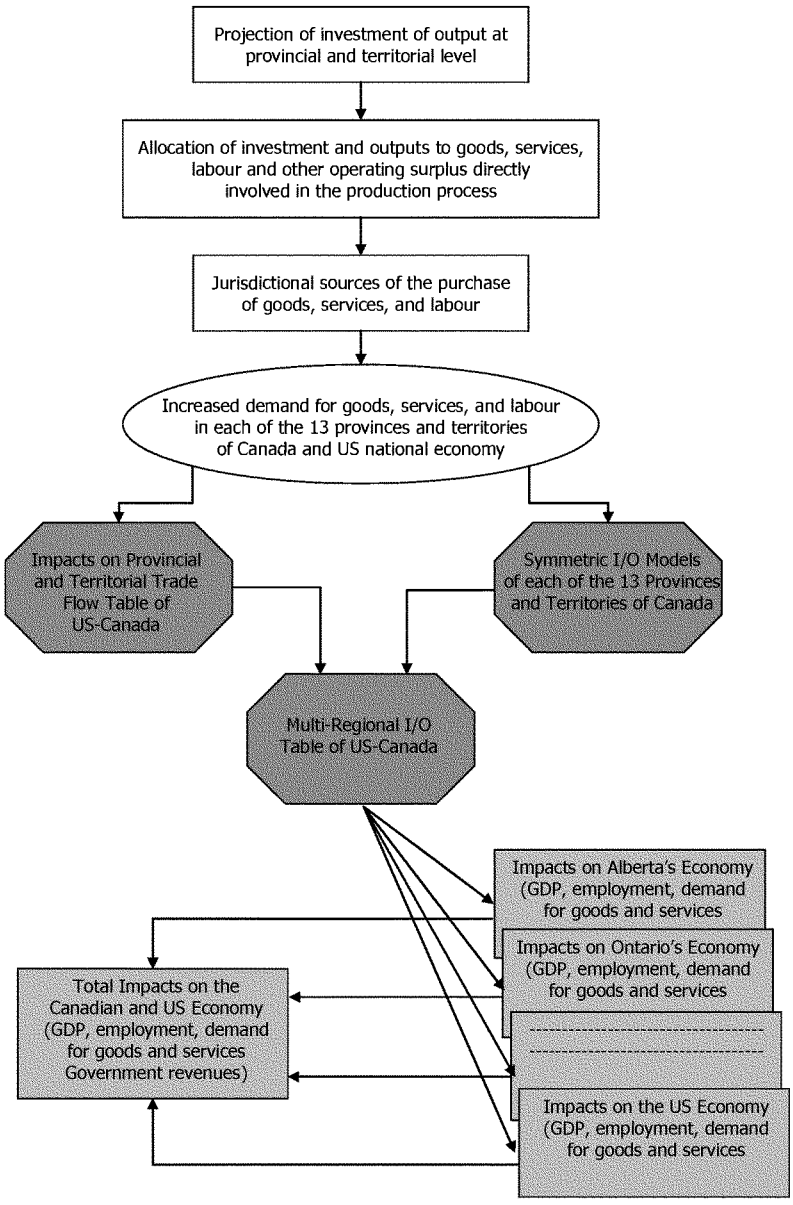
This appendix discusses briefly the methodology of this study. It is divided into four parts: overall modeling framework, the Multi-Regional I/O Model, data sources and assumptions.

The following sets out the various steps and processes in the compilation of the US-Canadian Multi-Regional I/O tables, and shows how one can trace direct and indirect, and induced effects of the Canadian oil sands sector on the Canadian and US economies. This will facilitate analysis of production and demand in Canada and the US, and allow economic studies at the provincial, state and national levels in both countries.

### B.1 Overall Modeling Framework: A Generic Approach

Any activity that leads to increased production capacity in an economy has two components: construction (or development) of the capacity, and operation of the capacity to generate outputs. The first component is referred to as investment, while the second is production or operation. Both activities affect the economy through purchases of goods and services, and labour. Figure B.1 illustrates the overall approach CERI uses to assess economic impacts resulting from these activities.

**Figure B.1**
**Overall US-Canada Multi-Regional I/O Modeling Approach**



The first step is to estimate the value of investment (i.e., construction or development expenditure) and production (sales). The total investment or development expenditures are then disaggregated into purchases of various goods and services directly involved in the production process (i.e., manufacturing, fuel, business services, etc.) and labour, using the expenditure shares. In a similar way, the value of total production (or output or sales) from a production activity (i.e., oil sands or conventional oil production, petroleum refinery, etc.) is allocated to the purchase of goods and services, payment to labour, payment to government (i.e., royalty and taxes) and other operating surplus (profits, depreciation, etc.).

The shares across goods and services, and labour, combined with the estimated values of investment and production, are then used to estimate demand for the various goods and services, and labour used in both development and production activities. These demands are met through two sources: (i) domestic production, and (ii) imports. Domestic contents of the goods and services are calculated using Statistics Canada's data and data from the BEA.

It is important to note that investment and operation expenditures are initially determined on a project basis, totaled and allocated to the production type level (i.e. mining and extraction, In Situ, integrated mining, extraction and upgrading and stand alone upgrader). These dollars are used in the model to "shock" the Alberta economy in various sectors (coincident shocks) including the Oil Sands, the Construction, the Refinery, and the Manufacturing sectors. These shocks are considered at the field plant outlet, or to the upgrader outlet for a stand-alone upgrader, and include bitumen and SCO products. The relationship between the Oil Sands industry and the Pipeline and Refining industries is captured in the base economy and thus shocks on the supply side results in impacts on these and other industries. The US sectors are represented in the model as the 14th segment (10 Canadian provinces + 3 territories + US). Investment shocks in Alberta result in impacts to the US economy at the sector level. The BEA data is used to link these shocks on the US sectors to the US state and US industry levels. Thus refinery upgrades to handle oil sand crudes are not directly handled by the model but generic refiner upgrades would be associated with the indirect impact relationship between the investment shocks and the refinery sector (both in Canada and the US). In other words, investment and operating dollar shocks are only done to Alberta industries; no direct shocks are made to the US sectors. Hence, the economic impacts reported herein do not capture the direct investments in US refineries that may be undertaken to process increased crude oil from Canada.

Inter-regional trade flow tables, developed by CERI, are used to derive import or export shares for each type of good and service for all 13 provinces and territories in Canada and the United States. The value of goods and services required by a particular industry and produced in each province or territory of Canada or the US is calculated using the import and export shares. The economic impacts of the production of these goods and services in a particular province or territory of Canada or the US are calculated in the same way as for other provinces and territories.

### B.2 CERI US-Canada Multi-Regional I/O Model (UCMRIO)

This section discusses the multi-stage process to build the UCMRIO model. As previously mentioned, CERI developed a Multi-Regional I/O model for Canada, as a part of examining the economic impacts of the Canadian petroleum industry on Canada's provinces and territories. CERI's UCMRIO model builds on the Multi-Regional I/O model for Canada, and is therefore prudent to review it, followed by a discussion of the UCMRIO model. Both approaches are defined in the System of National Accounts (SNA) terminology as industry-by-industry, or "industry technology". The multi-regional tables have the following advantages:

- Compatibility with economic theory;
- Recognizing institutional characteristics in each industry;
- Preserving a high degree of micro-macro link;
- The maximum use of the detailed information in Supply (make) and Use Tables (SUTs);
- Comparability with other types of statistics; and
- Transparency of compilation method, resource efficiency, support for a wider and more frequent compilation of input-output tables internationally.

The following is a brief description of the steps which have been taken in construction of the UCMRIO model, and will be divided into four parts: CERI Multi-Regional I/O Model of Canada, US I/O Model, US-Canada Trade Table and Model Structure and, finally, Disaggregation of National Results to the US.

#### B.2.1 CERI Multi-Regional I/O Model of Canada

In summary, the multi-regional I/O model consists of 13 provincial and territorial Symmetrical I/O Tables (SIOTS) and a trade flow matrix, the latter of which identifies the trade structure of provinces. The SIOTs are based on national and provincial I/O tables produced by Statistics Canada.[19] More specifically, CERI uses the provincial *Make, Use, and Final Demand* tables to construct the SIOTs for every province and territory in Canada. Each province's SIOT consists of linkages between 31 industries. For that reason, the provincial SIOTs are matrices of 31×31 dimension. There are several methods of constructing the provincial industry-based SIOTs; CERI employed the fixed product sales structures method. The SIOTs are essential in building the new Multi-Regional I/O tables, and conducting I/O analysis.

The provincial (or interprovincial) trade flow table is developed by CERI. Whereas the provincial SIOTs are industry-by-industry elements, the provincial trade flow tables are industry/province elements. Statistics Canada also publishes the provincial trade flow table, but at a small

[19] Statistics Canada, "The Input-Output Structure of the Canadian Economy, 2003-2004," *Catalogue No. 15-201-X*, February 2008.

aggregation level. This table presents the import and export flows among all provinces and territories in Canada, depicting the export of every industry to other provinces and territories in rows and the import of every industry from other provinces and territories in columns. Given there are 13 provinces and territories and each provincial SIOT consists of 31 industries, the provincial trade flow table is a matrix of 403×403 dimension.

The Statistics Canada I/O structure, as mentioned above, consists of three tables (or matrices): (i) "Make" or "Output" matrix, (ii) "Use" or "Input" matrix, and (iii) "Final Demand" matrix. The *Make* matrix presents production of commodities (row) by various industries (column). The *Use* matrix presents consumption or use of commodities (row) by various industries (column). The *Final Demand* matrix presents consumption or use of commodities (row) by various final demand sectors (column), such as household, government, investment, trade and inventory. The CERI Multi-Regional I/O model database combines these three matrices, data from national and provincial accounts, and the provincial trade flow table to form national and provincial social accounting matrices.

### B.2.2 US I/O Model

This section reviews briefly the next element of the UCMRIO, the US I/O table. Just as Statistics Canada produces provincial *Make, Use, and Final Demand* tables, the BEA[20] publishes the *Make*, *Use* and *Final demand*.

CERI uses the same procedure explained in the previous section to construct the SIOT for the US. Since this table is going to be merged with the Canadian SIOTs, the structure of the table is designed in such a way that it is compatible with other SIOTs in the model. As such the US SIOT consists of linkages between 31 industries. The classification of industries in both countries is identical. Table B.1 provides a brief description of these aforementioned sectors or commodities.

[20] http://www.bea.gov/regional/index.htm

**Table B.1**
**Sectors/Commodities in CERI US- Canada Multi-Regional I/O Model**

| Serial No. | Sector or Commodity | Examples of activities under the sector or commodity |
|---|---|---|
| 1 | Crop and animal production | Farming of wheat, corn, rice, soybean, tobacco, cotton, hay, vegetables and fruits; greenhouse, nursery, and floriculture production; cattle ranching and farming; dairy, egg and meat production; animal aquaculture |
| 2 | Forestry and logging | Timber tract operations; forestry products: logs, bolts, poles and other wood in the rough; pulpwood; custom forestry; forest nurseries and gathering of forest products; logging. |
| 3 | Fishing, Hunting and Trapping | Fish and seafood: fresh, chilled, or frozen; animal aquaculture products: fresh, chilled or frozen; hunting and trapping products |
| 4 | Support Activities for Agriculture and Forestry | Support activities for crop, animal and forestry productions; services incidental to agriculture and forestry including crop and animal production, e.g., veterinary fees, tree pruning, and surgery services, animal (pet) training, grooming, and boarding services |
| 5 | Conventional Oil[21] | Conventional oil, all activities e.g., extraction and services incidental to conventional oil |
| 6 | Oil sands | Oil sands, all activities e.g., extraction and services incidental to oil sands |
| 7 | Natural Gas and NGL | Natural gas, NGL, all activities e.g., extraction and services incidental to natural gas and NGL |
| 8 | Coal | Coal mining, activities and services incidental to coal mining |
| 9 | Other Mining | Mining of iron, metal, and gold and silver ores; copper, nickel, lead, and zinc ore mining; non-metallic mineral mining and quarrying; sand, gravel, clay, ceramic and refractory, limestone, granite mineral mining and quarrying; potash, soda, borate and phosphate mining; all related support activities. |
| 10 | Refinery | Petroleum and coal products; motor gasoline and other fuel oils; tar and pitch, LPG, asphalt, petrochemical feed stocks, coke; petroleum refineries |
| 11 | Petrochemical | Chemicals and polymers: resin, rubber, plastics, and fibers and filaments; pesticides and fertilizers; etc |
| 12 | Other Manufacturing | Food, beverage and tobacco; textile and apparel; leather and footwear; wood products; furniture and fixtures; pulp and paper; printing; pharmaceuticals and medicine; non-metallic mineral, lime, glass, clay and cement; primary metal, iron, aluminum and other metals; fabricated metal, machinery and equipment, electrical, electronic and transportation equipment, etc. |
| 13 | Construction | Construction of residential, commercial and industrial buildings; highways, streets, and bridges; gas and oil engineering; water and sewer system; electric power and communication lines; repair construction |
| 14 | Transportation and Warehousing | Roads, railways; air, water & pipeline transportation services; postal service, couriers and messengers; warehousing and storage; information and communication; sightseeing & support activities |
| 15 | Transportation margins | Transportation margins |

[21] Statistics Canada reports the oil, gas, coal and other mining as one sector due to some confidentiality issues. CERI, uses an in-house developed approach to disaggregate this sector to five sectors: Oil Sands, Conventional Oil, Gas+NGL, Coal and other mining.

**Table B.1 (continued)**

| | | |
|---|---|---|
| 16 | Utilities | Electric power generation, transmission, and distribution; natural gas distribution; water & sewage |
| 17 | Wholesale Trade | Wholesaling services and margins |
| 18 | Retail Trade | Retailing services and margins |
| 19 | Information and Cultural Industries | Motion picture and sound recording; radio and TV broadcasting and telecommunications; publishing; information and data processing services |
| 20 | Finance, Insurance, Real Estate and Rental and Leasing | Insurance carriers; monetary authorities; banking and credit intermediaries; lessors of real estate; renting and leasing services |
| 21 | Professional, Scientific and Technical Services | Advertising and related services; legal, accounting and architectural; engineering and related services; computer system design |
| 22 | Administrative and Support, Waste Management and Remediation Services | Travel arrangement and reservation services; investigation and security services; services to buildings and dwellings; waste management services |
| 23 | Educational Services | Universities; elementary and secondary schools; community colleges and educational support services |
| 24 | Health Care and Social Assistance | Hospitals; offices of physicians and dentists; misc. ambulatory health care services; nursing and residential care facilities; medical laboratories; child and senior care services |
| 25 | Arts, Entertainment and Recreation | Performing arts; spectator sports and related industries; heritage institutions; gambling, amusement, and recreation industries |
| 26 | Accommodation and Food Services | Traveler accommodation, recreational vehicle (RV) parks and recreational camps; rooming and boarding houses; food services and drinking establishments |
| 27 | Other Services (Except Public Administration) | Repair and maintenance services; religious, grant-making, civic, and professional organizations; personal and laundry services; private households |
| 28 | Operating, Office, Cafeteria and Laboratory Supplies | Operating supplies; office supplies; cafeteria supplies; laboratory supplies |
| 29 | Travel, Entertainment, Advertising and Promotion | Travel and entertainment; advertising and promotion |
| 30 | Non-Profit Institutions Serving Households | Religious organizations; non-profit welfare organizations; non-profit sports and recreation clubs; non-profit education services and institutions |
| 31 | Government Sector | Hospitals and government nursing and residential care facilities; universities and government education services; other municipal government services; other provincial and territorial government services; other federal government services including defense |

It is important to mention that the base years for the US and Canada is identical, again for compatibility reasons. As the Canadian I/O tables are based on 2003 numbers issued by Statistics Canada, CERI uses the 2003 figures in constructing the US I/O table. The yearly-average exchange rate for the same is used as we needed to exchange the numbers among US and Canadian dollars.

### B.2.3 US-Canada Trade Table and Model Structure

This section discusses the construction of the trade flow matrix, an important component to the modeling process. This step connects the US I/O table to CERI's Multi-Regional I/O model for Canada, and depicts a trading pattern between each Canadian province and territory with the US economy. The trade flow table for UCMRIO is a table which depicts the export/import flows of each Canadian province with the US and among each other. In particular, this table shows the import (export) flows of say, Alberta to the US and the other 12 Canadian provinces and territories. It is important to mention that the industry specification of this table is the same as SIOTs, and thus covers the trade flows among all sectors of the economies.

The following is a brief discussion of the modeling.

Based on a standard I/O model notation, and considering total gross outputs vector (GO), final demand vector (FD), and all calculated within multiregional technical coefficient matrixes, the following relationship in Multi-Regional I/O context holds as:

$A \times GO + C \times GO + R' \times GO + FD = GO$

This gives $(I - A - C - R') \times GO = FD$

Rewriting finally yields $GO = (I - A - C - R)^{-1} \times FD$, provided that $(I - A - C - R)$ is a nonsingular matrix.

As is the case for standard I/O models, the impact of an industry, such as the oil sands industry, is calculated by modeling the relationship between total gross outputs and final demand as follows:

$$\Delta GO = [I - A - C - R']^{-1} \times \Delta FD \qquad \text{(Equation I)}$$

Where:

$\Delta$GO Changes (or increases) in total gross outputs of the US and all provinces and territories, at the sectoral level, due to construction and operation of projects (i.e., oil sands). This is a 434×1 vector.

I Is a 434×434 matrix. I is an identity matrix, a matrix with unity for diagonal elements and zero for the rest of the matrix.

A Is a 434×434 block diagonal matrix of technical coefficients at the sectoral level for US and Canada. It is composed of 14 blocks so that each block is a 31×31 matrix corresponding to the US and each province's (or territory) input technical coefficient matrix.[22] An element of such a matrix is derived by dividing the value of a commodity used in a sector by the total output of

[22] In other words, one can say all 13 provinces' and one US input technical coefficients matrices are stacked together in construction of a diagonal block matrix at the national level.

that sector. The element represents requirements of a commodity in a sector to produce one unit of output from that sector.

C Is a 403×403 matrix at the sectoral level for Canada and US. Each of its elements measures the final consumption shares in a sector's total gross output in a province (or territory) and US.

R' Is a 403×403 transposed matrix of multiregional trade coefficients. It includes import and export shares of a sector's total output in US and province or territory. Each element on the row of this matrix measures the share of export to a particular sector in US or province from a given sector in another province or territory or US. [23]

ΔFD Is a 434×1 vector of changes (or increases) in final demand at the sectoral level outputs from Canada and the US resulted from any change in the final demand components in US or any province or territory, including commodity directly demanded (or purchased) for the construction and development of any sector.

The calculation of total impact is based on the multiplication of direct impact and the inverted matrix. Based on the direct impact on a sector, the Equation (I), above, is used to estimate all the direct, indirect and induced effects on all sectors in all provinces, particularly in terms of changes in consumption, imports, exports, production, employment, and net taxes. The direct impact is referred to $\Delta F$ in Equation (I). The change in final demand ( $\Delta F$ ) consists of various types of investment expenditures, changes in inventories, and government expenditures. In the current model, the personal expenditures are not part of the final demand and have been endogenized to accommodate the induced impact. Almost 50 percent of the GDP (total final demand) is composed of personal expenditure. Therefore, CERI shocked the final demand by only half of the operating costs.

Direct impacts are quantitative estimations that are made up of the main impact of the programs, in the form of an increase in final demand (increase in public spending, increase in consumption, increase in infrastructure investment, etc). The assumption of increased demand includes a breakdown per sector, so that it can be translated into the following matrix notation:

Direct, indirect and induced impacts:

$$\Delta GO = [I - A - C - R']^{-1} \times \Delta F \qquad \text{(Equation II)}$$

Direct and indirect impacts:

$$\Delta GO = [I - A - R']^{-1} \times \Delta F \qquad \text{(Equation III)}$$

[23] In particular, this matrix is a bridge matrix which connects the US, or any province, to other provinces through import and export coefficients.

The difference between Equations (II) and (III) is referred to as the induced impact of any changes in final demand components.

Once the impact on output (change in total gross outputs) is calculated, the calculations of impacts on GDP, household income, employment, taxes, and so forth, are straightforward. In particular, as previously mentioned, the base year for the I/O tables used in this report is 2003. CERI utilized the tax coefficients derived from these tables to calculate the total collected taxes. It is worth mentioning that the disaggregating of the collected taxes to federal and provincial taxes is based on the figures and ratios from the *Finances of the Nation*,[24] where these numbers reflect the tax structure of the Canadian economy in the year 2006. CERI acknowledges that there have been changes to the corporate income tax structure and the goods and services sales tax (GST) since 2006. The new tax regime will result in changes in tax figures and other numbers in the economy since the business will respond to the new incentives. This will be reflected in the upcoming I/O tables released by Statistics Canada.

These impacts are estimated at the industry level using the ratio of each (i.e., GDP) to total gross outputs. Using the technical Multi-Regional I/O table, CERI is able to perform the usual I/O analysis at the provincial and national levels.

### B.2.4 Disaggregation of National Results to the US

To report the US economic impacts down to the state level, CERI constructed a series of disaggregating coefficients. This process allows CERI to illustrate the economic impacts of the oil sands developments in Canada on each US state economy.

The BEA publishes detailed information on the sectoral economic variables such as GDP, and employment for the US states.[25] CERI uses the most recent data (year 2007) to establish a series of coefficients to disaggregate the national figures to state levels. For instance, to disaggregate national agricultural GDP among all states, CERI uses a set of 51 share coefficients, one for each state and the District of Columbia, to disaggregate the national numbers.

It is evident that the sum of these coefficients is equal to unity and they depict the share of each state in the GDP of the US economy. The similar sets of coefficients are calculated for each sector of the economy. Following this procedure, we use the GDP coefficients to disaggregate the sectoral GDPs and employment coefficients to disaggregate the sectoral employments. Changes in output, GDP, and employment are among the results that the model produces.

## B.3 Data Sources

This section reviews briefly data sources in both the US and Canada.

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[24] Treff, Karin and David Perry, Finances of the Nation 2007.
[25] See http://www.bea.gov/regional/gsp and http://ww.bea.gov/regional/spi .

As previously mentioned, the annual US input-output tables are available through the BEA. The *Make, Use and Final Demand* tables are quite detailed at the industry level and are available since 1947. The 85-industry, 365-industry and 596-indusry are a few examples of table formats issued by the BEA. Statistics are in compliance with the definitions of the 1997 North American Industrial Classification System (NAICS).

The *Use* table shows the inputs to industry production and the commodities that are consumed by final users. The *Make* table on the other hand depicts the commodities that are produced by each industry. In this report we use the *Make and Use* table to construct the US symmetric I/O table consistent with the Canadian Multi-provincial I/O tables developed by CERI.

The National Accounts and I/O tables in Canada were also developed at the conclusion of the Second World War. Tables in the present format, however, were first published in 1969 for the base year 1961. The I/O accounts are one of four main accounts that are published by the CSNEA, the others being income and expenditure accounts, financial and wealth accounts, and balance of payments accounts.

The I/O accounts are calculated at the national, provincial and territorial level, but on an annual basis only.[26] These tables are available at different levels of aggregation[27] on the Canadian Socio-Economic Information Management System (CANSIM) Tables 381-0009 to 381-0014. Provincial I/O data are also available on an occasional basis.

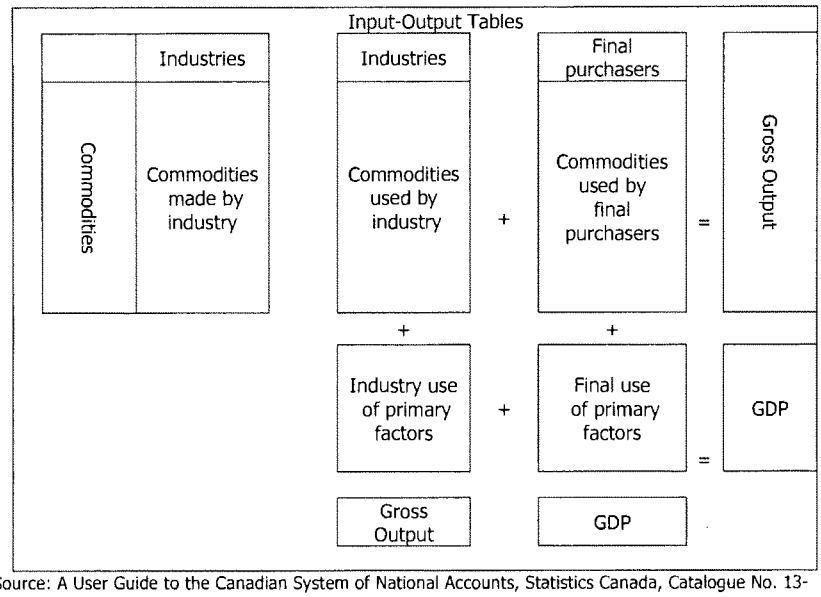
The framework of both the US and Canadian I/O system is complementary and consists of the following three basic tables:

- Gross output of commodities (goods and services) by producing industries;
- Industry use of commodities and primary inputs (the factors of production, labour and capital, plus other charges against production such as net indirect taxes); and
- Final consumption and investment plus any direct purchases of primary inputs by final demand sectors.

Figure B.2 is a schematic of the I/O system, and combines features of both the US and Canadian system and the more traditional single matrix presentation.

[26] The I/O tables and models, published annually by Statistics Canada, are entitled "The Input-Output Structure of the Canadian Economy". This document covers the basic concepts related to the I/O tables. Each year, two years of data are reported; the latest year is considered preliminary and the previous one is considered final. There are also many documents which are available on request from the I/O division.
[27] The I/O Tables of this publication are stored in CANSIM at the Small (S) level, Medium (M) level and Link (L) level of aggregation.

**Figure B.2**
**Schematic of the Input-Output System**




Source: A User Guide to the Canadian System of National Accounts, Statistics Canada, Catalogue No. 13-589E, November 1989.

## B.4 Assumptions and Limitations

The main assumption of any I/O analysis is that the economy is in equilibrium. Despite partial equilibrium analysis, it is assumed in the general equilibrium (GE) approach that the economy as a whole is in equilibrium. This is a realistic assumption in the long run, as it is difficult to imagine an economy remaining in disequilibrium for a long time period.

A second important assumption in I/O analysis is the linear relationship between inputs and outputs in the economy. Each sector uses a variety of inputs in a linear fashion to produce various final products. Though the form of the production function is simple, this could be viewed as an approximation of the real world's production function. A very interesting aspect of this assumption is the constant return to scale (CRS) property of the production function, which turned out to be a proven property in the real world economy. Though the linearity of the production function gives a constant average and marginal products, these are justified if the analysis focuses to the long-run rather than the short-run.

Although the I/O approach has been widely used around the world for economic impact assessment, there are certain limitations that should be noted. I/O matrices are limited to the estimation effect on demand, rather than supply. Therefore, they do not take into account

important objectives such as lasting effects on productive potential. Most effects on supply, which are likely to lead to a sustainable increase in the growth rate of assisted sectors (or provinces/states) and enable them to catch up with more developed sectors (or provinces), are completely disregarded. Some of these overlooked points include: the creation of new productive capacity, improvement of the training and education of the workforce, construction of infrastructure, productivity gains throughout the economy, spread of technological progress, and intensity of high-tech activities in the productive sector. All these effects on supply can transform productive capacity in a lasting and irreversible manner. These cannot be estimated using this multi-regional I/O tool.

In particular, several other well-known limitations of the I/O approach are discussed below:

***Static relationships.*** I/O coefficients are based on value relationships between one sector's outputs to other sectors. The relationship and, thus, the stability of coefficients could change over time due to several factors including:

- Change in the relative prices of commodities;
- Technological change;
- Change in productivity; and
- Change in production scope and capacity utilization.

Since these attributes cannot be incorporated in a static I/O model, these models are primarily used over a short-run time horizon, where relative prices and productivity are expected to remain relatively constant. Hence, over a longer period, static I/O models are not the best tools for economic impact analysis. GE models or macroeconomic models accounting for the factors mentioned above could be more appropriate. Moreover, I/O models and other static macroeconomic models and general equilibrium models do not account for sectoral dynamics and adjustment in an economy.

***Unlimited resources or supplies.*** The I/O approach simplistically assumes that there are no supply or resources constraints. In reality, in the short run, increasing economic activities in a particular sector of the economy may put pressure on wages and salaries. However, in the long run, the economy adjusts through the mobility of the factors of production (i.e., labour and capital).

***Lack of capacity to capture price, investment and production interactions.*** An I/O model is incapable of representing the feedback mechanism between price change, investment and production. For example, an increase in oil price provides a signal to investors to increase investment. The increase in investment would add productive capacity (more drilling) and also the production. However, this type of interaction cannot be modeled in a simple I/O model.

## About CERI

The Canadian Energy Research Institute (CERI) is a co-operative research organization established through an initiative of government, academia, and industry in 1975. The Institute's mission is to provide relevant, independent, objective economic research and education in energy and related environmental issues. Related objectives include reviewing emerging energy issues and policies as well as developing expertise in the analysis of questions related to energy and the environment.

For further information, see our web site: www.ceri.ca

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[Additional information is available at http://www.eipa.alberta.ca/media/39640/
life%20cycle%20analysis%20jacobs%20final%20report.pdf.]

Mr. WHITFIELD. Thank you.

Mr. Smith, you are now recognized for 5 minutes.

**STATEMENT OF MURRAY D. SMITH**

Mr. SMITH. Well, thank you, Chairman Whitfield and members of the committee. And as Canadians, let me thank you for holding this hearing in March and not in July or August. It has been my privilege to serve Albertans as minister of energy, elected position, from 2001 to 2004. During that time, I was able to quantify and register the 176 billion barrels of oil sands resource, proven oil sands resource with the U.S. Energy Information Agency. This move catapulted Canada's total proven oil reserves from less than 1.4 percent of the world's supply to over 15 percent, and we believe, as you have heard, that there are many more barrels to come and only technology will unlock this resource.

How did Alberta move from this? We started from scratch, 1967, with a joint government-private sector consortium, and today's production levels of over 1.7 million barrels today is a compelling story of human will, initiative, and technology evolution. And it would not have been possible without significant contributions from U.S.-based companies. Now, Alberta owns these resources and manages them on behalf of the citizens of Alberta. And today, some scant 50 years later, the oil sands is the largest investible resource in the world today where private dollars can flow in from private companies into a jurisdiction that respects property rights and ownerships.

Oil sands projects are carefully regulated on multiple levels and learning and improving operations all the time. Mined permits, facilities, must go through extensive review before approval is granted, and after approval, construction and fabrication is carefully monitored with annual plans in development submitted for mandatory approval. As the projects begin to produce, there is again extensive oversight. There are no reports of oil spills from oil sands reserves.

As oil is produced and shipped, there are in place numerous monitoring programs, and today this oil is shipped primarily to the USA. And a recent EIA report in February showed that retail gas prices in areas where oil sands oil is delivered to other regions of the USA, the difference in price is as much as 50 cents per gallon where there has been reports of Alberta oil in that region. And that is in the EIA report.

Throughout this period, technology innovation and continuous improvement have been Keystone's and oil sands development. Government policy including land sales, royalty, and tax assistance, and in some cases actual funding and partnership with industry have created a wealth-creating job-generating engine over many years. In 1993, the oil sands have moved primarily from the production of two operators and production was 300,000 barrels a day. Government of Alberta royalty revenues have been suffering from low commodity prices. We had a government that had a deficit that exceeded revenue by some 25 percent, debt levels were ap-

proaching 28 billion. We are 100th the size of this country. Oil sands investors asked for a level playing field, a generic royalty structure, and an accelerated tax recognition of their investments. They received no direct benefits unless they invested their money first. A tax on machinery and equipment was phased out, royalty structures became based on a payout period, royalties started low, and as projects paid out, increased to 25 percent of net profit.

Today, Mr. Chairman, oil sands royalties exceed those collected from all our natural gas production and the problems in Alberta. So with this structure and investment, billions of dollars poured in. We increased production to 600,000 barrels per day by the time I got elected in 1993. In 2003, the world became aware of this resource and it created a stampede of investment. It created technological innovation that basically has coined the oil sands as the world's engineering sandbox.

Let me just give you one example. Williams is an active, respected, midstream gas USA company. They have developed and deployed a technology that we use as surplus gases emitted from the coking process that upgrades bitumen to a transferable form. Now, as the gases are emitted from the coking process, Williams traps these gases. They then remove the propane, butane, and higher C5 gases for use in sale later in the gas stream. They return dry, clean-burning gas back to the coker. This elegant but simple process now removes over 300,000 tons of CO2 from the atmosphere each and every year. They have the potential to put four or more plants in that area resulting in over some million tons per year in reductions.

So as a former politician, Mr. Chairman, let me just outline the changes. We balanced our budget in 1995 after implementing the Oil Sands Royalty Program. All of our provincial debt was paid off in 2004. We had never increased taxes. We in fact refunded cash to the citizens of Alberta. We have doubled the Medical Research Fund. We have doubled the Alberta Ingenuity Fund, and we have created a sustainability and capital plan that allowed us to go through the difficult times of the last 3 years. And then in 2004, the book showed a stunning $68 billion turnaround from the dismal economic situation of 1993.

Let me finish, Mr. Chairman, with two quick stories. 2005, 60 Minutes aired a special on the oil sands. A 22-year-old trucker said he made $120,000 that year. The end of the program the CBS phone line system was so deluged with calls it crashed. Over 1,500 Americans ranging from truck drivers to nuclear engineers phoned in. What did they want? Jobs.

So let me finish with a quote from our great neighbor to the south, Governor Schweitzer, Brian Schweitzer, who realizes that production from Alberta will be secure, reliable, non-geopolitical, reasonably priced energy. And he says, "I do not believe that we will ever have to send the National Guard to Alberta to protect our oil supply." Now Alberta is the number one energy supplier to the USA and the dialogue and the insight that your wisdom has shown in calling this committee meeting, Mr. Chairman, that will be gained today is critical to maintaining that special relationship. Thank you for this opportunity to serve the House of Representatives.

[The prepared statement of Mr. Smith follows:]

Members of the committee, thank you for the opportunity to present the energy technology story for the oilsands of Alberta, Canada.

It has been my privilege to serve Albertans as Minister of Energy from 2001 to 2004, during that time I was able to quantify and register the 176 Billion Barrels of oil resource with the US Energy Information Agency. This move catapulted Canada's total oil reserves from 6 % of the world supply to over 16 %. We believe there are as much as 307 Billion Barrels of recoverable resource and over 1.2 trillion Barrels in place. Only technology will unlock this critical resource.

How Alberta moved from starting oilsands development in 1967, from scratch, with a joint government / private sector consortium to todays production levels of over 1.7 million Barrels /Day is a compelling story of human will, initiative and technology evolution. It would not have been possible without great contributions from USA based companies like Cities Services, Exxon and ARCO to name a few. Importantly the province of Alberta owns these resources and manages them on behalf of the citizens of Alberta.

Today in 2012 some scant 50 years later, the oilsands is the largest "investible "resource in the world today. By investible, I mean private dollars that can flow in from

private companies into a jurisdiction that respects the rules of property rights and ownership.
The oilsands is carefully regulated on many levels. Mine permits and facilities applications must go through extensive review before approval is granted for development.
After approval, construction and fabrication is carefully monitored with annual plans and developments submitted for mandatory approval.
As the projects begin to produce, there is again extensive oversight from the Alberta government and the regulator. There are no reports of oil spills from oilsands reserves.
As the oil is produced and shipped there are in place numerous monitoring programs. Today this oil is shipped primarily to the USA and in a recent report, there is evidence reported that retail gas prices, in areas where oilsands crude is delivered that price per gallon is as much as $.50 per gallon cheaper than in other regions of the USA that do not have access to Alberta oilsands crude.

Throughout this period technology innovation and continuous improvement have been keystones in oilsands development. Importantly, government policy and actual funding in partnership with industry have created this wealth creating, job-generating engine over many years.

So what has happened and how did we get here?

1n 1993 the oilsands had moved forward primarily from the production of two operators Syncrude and Suncor. Production was some 300,000 B/d and investors were reluctant to grow production and increase investment.

Government of Alberta royalty revenues had been suffering from low commodity prices, and deficit spending exceeded revenue by some 25%. Debt levels were approaching $28Billion. Crippling amounts for a small economy like Alberta.

Oilsands investors asked for a level playing field, a generic royalty structure, and accelerated tax recognition of their investments. They received no direct benefits or subsidies unless they invested their money first. A tax on machinery and equipment investment was phased out, based on levels of private sector investment. Royalty structure became based on payout period. Starting at a low point and increasing to $25 % of net profits.

With this structure, production increased from 300,000 B/d to over 600,000 B/d in 10 Years (a 7% annual year over year increase)
In 2003 the world became aware of the gigantic oil deposits of Alberta with official EIA recognition of the resource. This created a stampede of investment from around the world coupled with a surge in new technology focused on reduced green house gas

emissions, reduced environmental footprint in mining and "in situ" recovery, and cost and production efficiencies. The oilsands have been the worlds engineering "sandbox" for the past five years.
Great gains have been made, as you will hear today.
Let me just give one example: Williams is an active respected natural gas midstream USA based company. They have developed and have deployed a technology that reuses surplus gases emitted from the coking process that upgrades bitumen to a transferable form. As the gases are emitted from the coking process, Williams traps these gases. They then remove the propane, butane and higher c5+ gases for use and sale later in the gas stream. They return dry clean burning gas back to the cokers. This simple process now removes over 300,000 tons of CO2 from the atmosphere each and every year. They have the potential opportunity to place four or more plants in the area that will result in over 1 million tons per year reduction from gases to the atmosphere. This process creates wealth by converting and selling waste products that would have otherwise been released to the atmosphere. It creates high paying jobs in construction and plant operation. It gives North America a competitive edge in the world today.
This technology and the opportunity did not even exist 15 years ago.
I am sure you are anxious to hear further technological innovation in the oilsands, as other presenters will relate.

What's happened in Alberta? As a former politician who served 3 consecutive terms from 1993 – 2004, let me outline the changes.

As stated in 1993 Alberta, a province of 2.5 million people who had no disposable income increase in the past decade and provincial finances were gloomy with a spending profile that was 25% above income and a debt that grew to $28 Billion.

My political party, under the leadership of Premier Ralph Klein was elected on a platform to balance the budget, pay down debt and not increase taxes. , Alberta's deficit was eliminated (1995); all provincial debt was paid off in July 2004. Taxes were not increased; in fact Albertans received a cash refund from their government.

The Heritage Medical Research Fund, which provides scholarships to aspiring medical researchers, was doubled to $2Billion

The Alberta Ingenuity Fund, which grants funds to engineering innovation, was doubled to $2Billion

High school scholarships were doubled rewarding successful completion of high school in a 3-year period

A Sustainability Fund was created to weather economic downturns. A Capital fund was created to provide Albertans with new educational facilities, infrastructure and health care facilities, nurses, and doctors.

In all, thanks to government /private sector partnerships, a drive for technical innovation and human ingenuity Alberta was transformed.

In 2004, the books showed a stunning $68Billion turnaround from the dismal economic situation of 1993.

Albertans had the highest weekly earnings in Canada, the lowest unemployment rate, the lowest tax rate, and highest reported retail sales.

In 2005 when the famed "60 minutes " show aired a special on the oil sands, a 22-year-old trucker said he had made $120,000 the previous year. At the end of the program the CBS phone line system was so deluged with calls that the system crashed. Over 1500 Americans ranging from truck drivers to nuclear engineers phoned in. To a person they wanted jobs.

The oilsands remains a job-generating machine that is technology driven. The production of oilsands crude delivers more economic value per barrel to the USA than any other Barrel of oil produced in the world today. 470 ton trucks from Caterpillar (mostly diesel electric and fuel efficient). Tires from Michelin in South Carolina. Consulting brains and steel from Chicago Iron, The list is long, and the jobs are many.

The oilsands will continue to drive efficiency in cost and production practices. Producers will put a high price on workplace safety. Technology, Innovation and Continuous improvement will reduce green house gas emissions and overall environmental footprint. Reclamation practices improve on a daily basis.

The building of the oilsands has created more jobs, more entrepreneurship and more prosperity for First Nations and Aboriginal peoples than anyplace else in Canada or any other initiative.

The increase in production will benefit North America with secure reliable, non-geopolitical, reasonable priced energy. As Democratic Governor Schweitzer of our neighbouring state of Montana has said "I do not believe that I will ever have to send the National Guard to Alberta to protect our oil supply "

Alberta is the number one energy supplier to the USA and the dialogue and the insight such as will be gained today is critical to maintaining that special relationship.

Thank you for this opportunity to serve the US House of Representatives.

Mr. WHITFIELD. Thank you.
Mr. Dyer, you are recognized for 5 minutes.

**STATEMENT OF SIMON DYER**

Mr. DYER. Good morning, Mr. Chairman and committee. My name is Simon Dyer. I am the policy director with the Pembina Institute based in Alberta, Canada. The Pembina Institute is Canada's nonprofit sustainable energy think tank. We focus on energy solutions through research, education, consulting, and advocacy. We have a long history as the leading independent expert on oil sands environmental policy and performance. We have participated in the regulatory process in Alberta for 20 years and we conducted extensive research on policy solutions to current environmental problems in the oil sands.

The biggest impediment to progress on reducing the environmental impact of oil sands through the deployment of new technologies is the lack of regulatory policy to drive improved performance. All the major environmental accomplishments such as dealing with acid rain, the hole in the ozone layer, and removing lead from gasoline were all driven by regulatory approaches that resulted in increased environmental performance and technological innovation in the industry. In the oil sands, however, little attention has been focused on the appropriate role of government in regulating environmental performance, and thus, many of the environmental impacts continue to worsen today.

My comments, due to the short time, will be focused on greenhouse gas pollution but the same principles apply to other unresolved environmental impacts such as tailings waste management, fresh water use, air pollution, and land and wildlife impacts. Over the last two decades, oil sands greenhouse gas emissions have more than doubled. In 2009, oil sands operations in Canada emitted 45 megatons of greenhouse gases. According to recent projections by the Government of Canada, this is set to double again by 2020.

What is less well known is that oil sands greenhouse gas emission intensity—that is how much carbon dioxide per barrel produced—has actually worsened over the past 6 years. This has undone some of the improvements in the emissions intensity that other presenters have mentioned. Improvements since 1990 were largely driven by one-time changes like switching fuel from coke to natural gas and by incorporating cogeneration into projects. The insinuation that these kind of improvements will continue into the future is not supported by the evidence.

The worsening emission profile of the oil sands can be attributed to three main issues. Firstly, an increasing proportion of oil sands production will be coming from in situ oil sands development, as noted by other speakers here today. In situ development produces two-and-a-half times more greenhouse gas emissions per barrel than oil sands mining does. Secondly, as oil sands development increases, companies are exploring lower-quality and harder-to-access bitumen resources and developing these resources means increased environmental impacts per barrel. Thirdly, the very weak regulatory environment of the greenhouse gas management in Alberta and Canada does not require substantial improvements in greenhouse gas emissions.

As you may know, the Government of Canada has repeatedly failed to meet its own targets to reduce greenhouse gas pollution, and the oil sands are the major reason behind this. While most industries in Canada are holding steady, emissions in the oil sands continue to rise. A 2010 MIT study quantified this effect with economic models and concluded that the niche for the oil sands industry seems fairly narrow and mostly involves hoping the climate policies will fail. In Canada, hitting climate targets while the oil sands expand dramatically would mean asking every other sector in our economy to do more than their fair share, a prospect that is so unappealing that every Canadian environment minister to date has opted to miss their targets instead.

Much attention has been paid to the potential role of carbon capture and storage, or CCS, in limiting greenhouse emissions from the oil sands. Indeed, Alberta's climate plan says CCS alone will account for 70 percent of Alberta's reductions by 2050. However, there are no operating CCS projects in the oil sands. One planned integrated project, Shell's Quest Project, proposes to capture 1.2 million tons of emissions from the Scotford Upgrader. This project will receive $865 million in subsidies from the Alberta and Federal governments.

While in principle, CCS could be applied at different stages of the oil sands, it is not economic under current policies. Carbon capture costs for oil sands projects range from 75 to $230 per ton of carbon dioxide. In Alberta, the effective carbon price is only $15 per ton of CO2. At this price level in the absence of further massive public subsidies, there will be no deployment of CCS in the oil sands beyond Shell's Quest Project.

Unfortunately, Alberta's climate plan states that 30 megatons of annual reductions will be derived by CCS by 2020, the equivalent of building 25 Quest-type projects in the next 8 years. Clearly, this is a fiction. For carbon capture to be economic, governments would either have to implement carbon prices an order of magnitude higher than they are currently or mandate carbon capture and storage for the oil sands industry.

In December, Pembina Institute conducted the first assessment of Alberta's climate plan. We concluded that Alberta will miss its emissions target by two-thirds. We characterized Alberta's climate plan as "a car without an engine," as many of the elements that could be effective but without a meaningful carbon price, it just won't run. The current frenzied rate of oil sands development in Canada is a symptom of our failure to implement policies and regulations to meet our commitments. Rosy projections of oil sands expansion are simply mathematically inconsistent with these commitments.

I would like to finally comment on the fact that Pembina Institute is supportive of voluntary measures in research and development by oil sands industry. It is important to distinguish between lab research and small-scale pilot projects and commercial penetration of new technologies. The commercial application of new technologies is simply not keeping pace with this expansion and the vast majority of new production will rely on conventional more polluting technology. This represents a significant opportunity lost

and can only be addressed through policy and regulatory intervention.

Thank you very much. I look forward to your questions.

[The prepared statement of Mr. Dyer follows:]

Good morning Chair and Committee

My name is Simon Dyer. I am the Policy Director with the Pembina Institute, based in Alberta, Canada.

The Pembina Institute is a Canadian non-profit think tank that advances sustainable energy solutions through research, education, consulting and advocacy. We have a long history as a leading independent expert on oilsands environmental performance and policy. We have participated in oilsands regulatory processes in Alberta for 20 years and conducted extensive research on policy solutions to current environmental problems in the oilsands.

The biggest impediment to progress on reducing the environmental impact of oilsands development through the deployment of new technologies is the lack of regulatory policy to drive improved performance. Major environmental accomplishments such as dealing with acid rain and the hole in the ozone layer and removing lead from gasoline were all driven by regulatory approaches that resulted in increased performance and technological innovation from industry. In the oilsands, however, little attention has been focused on the appropriate role of government in regulating environmental performance — and thus many environmental impacts continue to worsen.

My comments today, due to the short time, will be focused on greenhouse gas pollution, though the same principles apply to the other unresolved environmental impacts of oilsands development such as tailings waste management, fresh water use, air pollution and land and wildlife impacts.

**Oilsands are the fastest growing source of greenhouse gas pollution in Canada**

Over the last two decades, oilsands greenhouse gas emissions have more than doubled.[1] In 2009, oilsands operations in Canada emitted 45 million tonnes of

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[1] Oilsands emissions have grown from 17 Mt in 1990 to 45 Mt in 2009. Source: Environment Canada, *National Inventory Report - Part 1 1990-2008 Greenhouse Gas Sources and Sinks in Canada* (2010) 86, Table 2-16. http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=492D914C-2EAB-47AB-A045-C62B2CDACC29 Note: the value for 2009 oilsands total emissions was provided in e-mail communication from Environment Canada officials.

greenhouse gases (GHGs). According to recent projections from the Government of Canada, in a business-as-usual oilsands scenario this emissions growth will continue, with the total annual emissions from the oilsands doubling from 2009 to 2020.

What is less well known is that oilsands greenhouse emissions intensity — that is, how much $CO_2$ is emitted per barrel produced — has actually worsened over the past 6 years. This has undone some of the improvements in emissions intensity that other presenters have mentioned. Improvements since 1990 were largely driven by one-time changes like switching fuels from coke to natural gas, and by incorporating cogeneration into projects. The insinuation that these kinds of improvements will continue is not supported by recent evidence.

The worsening emissions profile for the oilsands can be attributed to three main issues that cannot be disputed:

First, an increasing proportion of oilsands production comes from insitu oilsands development instead of mining. Insitu development produces 2-and-a-half times more GHG emissions per barrel than oilsands mining does.

Second, as oilsands development increases, companies are exploring lower-quality and harder-to-access bitumen resources; developing these resources means increased environmental impacts.

Third, the very weak regulatory environment for greenhouse gas management in Alberta and Canada does not require substantial improvements in greenhouse gas emissions.

As you may know, the Government of Canada has repeatedly failed to meet its own targets to reduce greenhouse gas pollution, and the oilsands are a major reason behind this. While most industries in Canada are holding steady, oilsands emissions continue to rise. A 2010 MIT study quantified this effect with economic models, concluding that "the niche for the oil sands industry seems fairly narrow and mostly involves hoping that climate policies will fail." In Canada, hitting climate targets while the oilsands expand dramatically would mean asking other sectors to do more than their share — a prospect so unappealing that every Canadian environment minister to date has opted to miss our targets instead.

Much attention has been paid to the potential role that carbon capture and storage (CCS) could play in limiting GHG emissions from Canada's oilsands. This is partly because Alberta's climate change plan assumes that CCS alone will provide approximately 70%[2] of planned reductions from business-as-usual by 2050.

However, there are no operating CCS projects in the oilsands to date. One planned integrated project, Shell's Quest project, proposes to capture 1.2 million tonnes of emissions from the Scotford Upgrader.[3] This project will receive 865 million dollars in subsidies from the Canadian federal and Alberta governments. While in principle CCS could be applied at several different stages in the oilsands, it is not economic under current policies.

Projected carbon capture costs for oilsands projects range from 75 to 230 dollars per tonne.[4]In Alberta, the effective carbon price is set at only $15 per tonne of $CO_2$.[5] At this price level, and in the absence of further massive public subsidies, there will be no deployment of CCS in the oilsands beyond Shell's Quest project. Unfortunately, Alberta's climate plan states that 30 MT of annual reductions will be derived by CCS by 2020 — the equivalent of building 25 Quest-type projects in the next 8 years. Clearly, this is a fiction.

For carbon capture to be economic, governments would have to either implement carbon prices an order of magnitude higher than they have contemplated to date, or mandate carbon capture for the oilsands industry.

Last December, Pembina Institute completed the first and only comprehensive assessment of Alberta's climate change plan. By assembling government and

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[2] CCS accounts for 139 of a planned 200 MT of reductions by 2050.

[3] Shell Canada, "Oilsands: Shell's Quest." Accessed March 1, 2011. http://www.shell.ca/home/content/can-en/aboutshell/our_business/business_in_canada/upstream/oil_sands/quest/

[4] Ibid.

[5] $15/tonne is the charge that large emitters can pay into the province's Climate Change and Emissions Management Fund in order to comply with Alberta's Specified Gas Emitter Regulation, which mandates a 12% emission intensity reduction for heavy industry in the province. Government of Alberta, *Technical Guidance for Completing Specified Gas Compliance Reports,* (2010) 4,8. http://environment.alberta.ca/documents/Tech-Guidance-Doc-for-2009-Specified-Gas-Compliance-Reports.pdf.

industry data we concluded that Alberta will miss its emissions reduction target by 2020 by two-thirds. The primary reason for this failure is that Alberta does not place a high enough price on pollution to incentivize the kinds of reductions it has committed to in its plan.

We characterized Alberta's climate plan as a car without an engine. It has many elements that could be effective, but without a meaningful price that penalizes $CO_2$ pollution, the car won't run and it won't get Alberta to its stated destination.

In its 2010 World Energy Outlook, the International Energy Agency modelled a "450 Scenario" to project energy supply and demand that would be consistent with stabilizing atmospheric GHG concentrations at 450 parts per million of carbon dioxide. This scenario projects that oilsands production would continue to grow, although much more slowly than in the current unregulated environment, with production reaching just over 3 million barrels per day of production in 2035.[6] In other words, under this scenario Canada could have an oilsands industry and a carbon price while still meeting international climate targets.

The current frenzied rate of oilsands development is a symptom of Canada's failure to implement policies and regulations to meet its commitments to reduce greenhouse gas pollution. Rosy projections by industry for oilsands expansion are simply mathematically inconsistent with these commitments.

Finally, I would like to comment on the fact that while Pembina Institute is supportive of voluntary measures and research and development by the oilsands industry, it is important to distinguish among lab research, small-scale pilot projects and commercial penetration of new technologies. The commercial application of new technologies is simply not keeping pace with expansion, and as a result the vast majority of new production will rely upon conventional, more polluting technology. This represents a significant opportunity lost, and one that can only be addressed through policy and regulatory intervention.

In closing, I'd like to thank you for this opportunity to speak to you and look forward to your questions.

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[6] International Energy Agency, *World Energy Outlook 2010*, (2010), p.450

Written Testimony of

Simon Dyer

Policy Director

Pembina Institute

before the

U.S. House of Representatives

Committee on Energy and Commerce

Subcommittee on Energy and Power

March 20th, 2012

## Executive Summary

- As Canada's oilsands continue to expand production, the environmental impacts from oilsands development will also increase.
- The biggest impediment to progress on reducing the environmental impact of oilsands development through the deployment of new technologies is the lack of regulatory policy to drive improved performance.
- This testimony will focus on greenhouse gas emissions and the role of technology and public policy in the oilsands, though the same principles apply to the need to address other unresolved environmental impacts of oilsands development such as tailings management, water use, air emissions and land and wildlife impacts.
- The oilsands are a major and growing source of greenhouse gas emissions. Over the past six years, emissions have been rising on a per-barrel basis.
- Neither the Government of Canada nor the Government of Alberta has climate policies in place that will counter the fast growth of greenhouse gas emissions from oilsands.
- Alberta's climate targets are weak. Alberta's long-term climate target lags significantly behind the effort being made by many other industrialized nations — including the U.S.
- Alberta's climate plan is likely to achieve less than one-third of the reductions it calls for by 2020. This is due to weaknesses in the policies and accounting for emissions reductions.
- The projected increase in Canada's greenhouse gas emissions between 2005 and 2020 will come almost solely from the oilsands, but Canada's and Alberta's efforts to constrain these emissions is out of step with Canada's climate commitments.
- Carbon capture and storage and other experimental emission-reducing technologies are unlikely to significantly reduce emissions in the oilsands in the next 20 years.
- The rapid pace and scale of oilsands development also serves to undermine any incremental improvements from new environmental technologies.
- A stronger regulatory environment will not only moderate growth but also accelerate technological innovation by providing clear signals to oilsands companies to invest in new research and development. Without a meaningful and effective price on carbon, the cost of capturing emissions from many sources is likely to be prohibitive.

## About the Pembina Institute

The Pembina Institute is a Canadian non-profit think tank that advances sustainable energy solutions through research, education, consulting and advocacy. We promote environmental, social and economic sustainability in the public interest by developing practical solutions for communities, individuals, governments and businesses. The Pembina Institute provides policy research leadership and education on climate change, energy issues, green economics, energy efficiency and conservation, renewable energy, and environmental governance.

The Pembina Institute has a long history as a leading independent expert on oilsands environmental performance and policy. We have participated in oilsands regulatory processes in Alberta for 20 years and have conducted extensive research on policy solutions to current environmental problems in the oilsands.

## Role of regulation in environmental innovation in the Canadian oilsands

The biggest impediment to progress on reducing the environmental impact of oilsands development through the deployment of new technologies is the lack of regulatory policy to drive improved performance. Major environmental accomplishments, such as dealing with acid rain and the hole in the ozone layer and removing lead from gasoline, were all driven by regulatory approaches that resulted in increased performance and technological innovation from industry. In the oilsands, however, little attention has been focused on the appropriate role of government in regulating environmental performance — and thus many environmental impacts continue to worsen.

My comments today, due to the short time, will be focused on greenhouse gas pollution, though the same principles apply to the other unresolved environmental impacts of oilsands

development such as tailings waste management, fresh water use, air pollution and land and wildlife impacts.

# Oilsands are a major and growing source of greenhouse gas emissions

## Oilsands are the fastest growing source of greenhouse gas pollution in Canada.

Over the last two decades, oilsands greenhouse gas emissions have more than doubled.[1] In 2009, oilsands operations in Canada emitted 45 million metric tonnes (Mt) of greenhouse gases (GHGs), an increase of 22 million tonnes over 2000 levels. According to recent projections from the Government of Canada, in a business-as-usual oilsands scenario this emissions growth will continue, with the total annual emissions from the oilsands doubling from 2009 to 2020.[2]

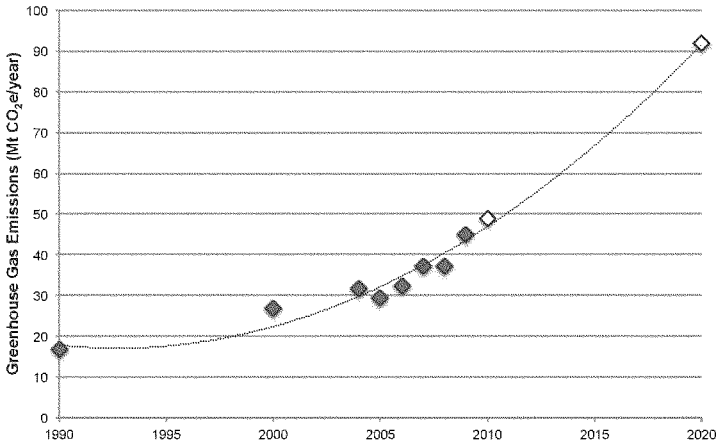


**Figure 1. Annual total oilsands greenhouse gas emissions**

Source: Data from 1990 to 2009[3] are actual measured values, while 2010 to 2020[4] represent Environment Canada's forecast values.

The rapid growth rate of oilsands GHG pollution is even more evident when compared with the projected emissions from other economic sub-sectors in Canada. As shown in Figure 2, GHG emissions are growing faster in the oilsands than any other sub-sector in Canada.

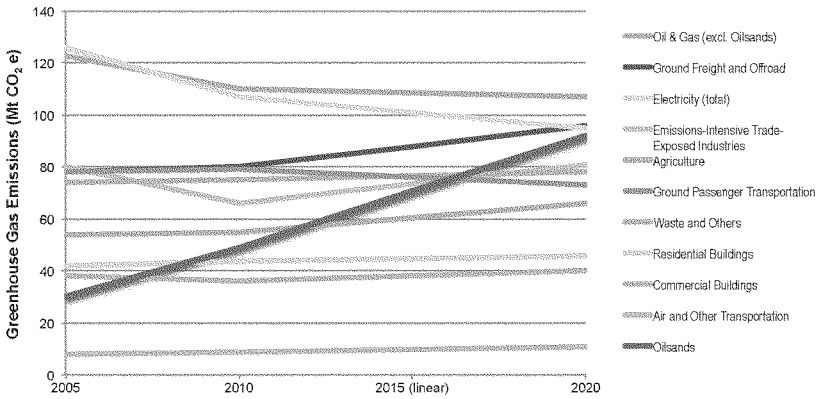


**Figure 2. Projected annual greenhouse gas emissions by economic sub-sector**
Figure produced from Environment Canada data[5]

## Extracting and upgrading synthetic crude from the oilsands is a very emissions-intensive means of producing transportation fuel

In comparison to conventional sources of crude, producing transportation fuels from the oilsands is a very energy-intensive process. The vast quantities of natural gas burned to power the oilsands industry result in unusually high GHG pollution. Numerous studies have compared the GHG intensity of oilsands with a variety of conventional crudes and other heavy or non-conventional fuel sources, and have shown oilsands at or near the top of the list of the most emissions-intensive commercial sources to date. Industry-wide average GHG emissions for oilsands extraction and upgrading are estimated to be 3.2 to 4.5 times greater per barrel than for conventional crude oil produced in Canada or the United States.[6]

The Royal Society of Canada Expert Panel on the Environmental and Health Impacts of Canada's Oil Sands Industry noted, "In summary, comparisons of GHG emissions from oil sands

with other petroleum sources is very dependent on the petroleum source that is used for comparison and the specific details concerning the processing of bitumen. Nonetheless, life-cycle GHG emissions from oil sands are in the upper part or at the top of range of all petroleum sources. In situ bitumen recovery is the highest for GHG emissions and its proportion of bitumen production is increasing."[7]

## Oilsands intensity improvements will not compensate for absolute oilsands growth

Environment Canada's most recent figures show that, from 1990 to 2009, oilsands GHG intensity (emissions per barrel produced) declined by 29%.[8,9] Industry advocates often use this statistic to imply that substantial intensity improvements will continue in the future. However, this is not likely to be the case.

While past technology and process improvements resulted in increased efficiency, a significant component of the intensity reductions from the past two decades were made possible by fuel switching from coke to natural gas[10] and by increased use of cogeneration of heat and electricity.[11] These one-time advances have been widely adopted across the industry and so are not likely to result in further significant GHG intensity reductions in the future.[12]

While new technologies are being researched that could potentially lead to future GHG intensity reductions, the long lag time between research, piloting and commercial deployment means that any benefits from the technologies are likely 15 to 20 years away.[13] In fact, as illustrated in Figure 3, the historical decline in GHG intensity now appears to have ended, with intensity levelling off and increasing somewhat over the past four years.

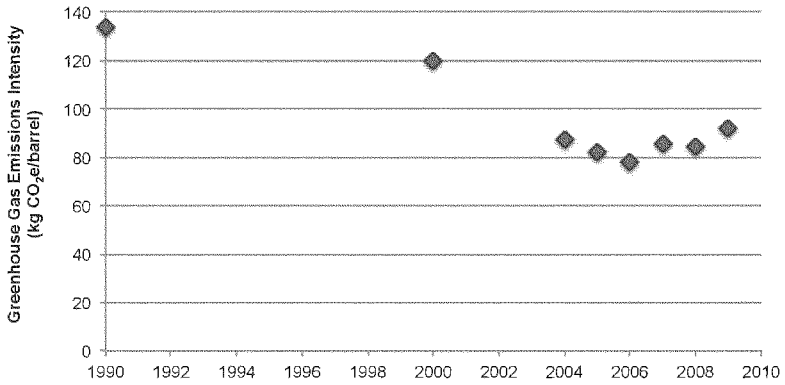


**Figure 3. Industry-wide greenhouse gas emissions intensity trends for oilsands**

Source: Emissions data from Environment Canada[14] and production data from Statistics Canada[15]

In addition, new intensity reductions brought by future technologies may be diminished or cancelled out by other changes to the industry. For example, current projects tend to start where the best bitumen reservoirs are located, but future oilsands operations are likely to be located at reservoirs that are less easily accessible, therefore requiring more energy and producing relatively higher GHG emissions.[16] Furthermore, in situ oilsands extraction — a significantly more GHG-intensive means of production (on average 2.5 times more intensive than mining)[17] — is expected to become a major portion of overall oilsands production over the next decade.[18] Such a shift would increase the industry-wide GHG intensity.

Another reason why continued GHG emission intensity reductions are unlikely is because the current weak regulatory environment for greenhouse gas management does not require substantial improvements in greenhouse gas emissions, as described below.

It is important to note that both the absolute and intensity-based GHG emissions do not account for land use change — a factor that is likely to be significant. A study published in the Proceedings of the National Academy of Sciences last week found that loss of peatland in the oilsands region is significant source of carbon pollution. The post-mining landscape in the oilsands region will support 65% (29,500 ha) less peatlands. From approved oilsands mines

alone, up to 47 Mt $CO_2$eq will be released from the carbon stored in the peatlands; the ecosystem will reduce its ability to absorb carbon by up to 7,000 tonnes per year.[19] Life cycle studies of oilsands emissions intensity do not incorporate this important information.

## Federal climate policies will fail to meet the country's 17% emissions reduction target unless the government increases its effort tenfold

### Current federal and provincial policies put Canada's GHG emissions on a trajectory to be 7% above the 2005 level by 2020, not 17% below it as the government has promised

Environment Canada's latest projections show that in the absence of any government policies to curtail emissions, and with mid-range assumptions about economic growth and the price of oil, Canada's annual GHG emissions would reach 850 Mt in 2020, compared to 731 Mt in 2005. When taking into account all currently announced federal and provincial climate policies, just one-quarter of the gap between our projected 2020 emissions and our 2020 target (17% below the 2005 level) will be closed, meaning that Canada's 2020 emissions would be 785 Mt.[20]

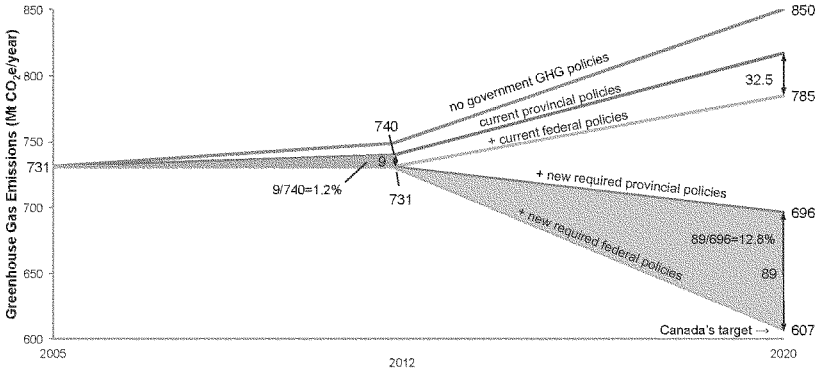


**Figure 4. Canada's greenhouse gas emissions 2005-2020**

Source: Pembina Institute presentation of data from Environment Canada[21]

The left-hand red shaded area in Figure 4, which depicts numbers published by Environment Canada, shows that during the Harper government's first seven years in office (2006–2012 inclusive), its efforts will have reduced Canada's annual emissions by 9 Mt or 1.2%, equivalent to 0.17% per year. The grey shaded area in the figure shows that during the subsequent eight years (2013–2020 inclusive), federal policies would have to reduce annual emissions by 89 Mt, or 12.8%, in order to meet Canada's 2020 target. Meeting this target is equivalent to 1.7% reductions each year. This indicates that a tenfold increase is required in the current federal policy implementation effort from now on.[22]

Overall, Canada's annual GHG emissions are projected to increase by 54 Mt between 2005 and 2020, under currently announced federal and provincial policies.[23] Emissions from the oilsands (including emissions from upgrading) are projected to grow by 62 Mt over the same period.[24] Because the ups and downs in emissions in other sectors largely cancel each other out, essentially the entire projected increase in Canada's emissions between 2005 and 2020 will come from the oilsands.

## New climate policies fail to raise the bar

The federal government is implementing new policies intended to slow the future growth in Canada's GHG emissions. The most significant of these include regulated emission standards for cars and trucks based on the U.S. regulations, stronger efficiency standards for energy-using equipment, and public investment in four industrial-scale CCS projects (two in the oilsands). The government is also proposing to regulate GHG emissions from coal-fired electricity generation, starting in 2015.

However, the effectiveness of these initiatives is questionable. Loopholes in the car regulations, and the fact that Canada's fleet is historically more efficient than the U.S. fleet, may allow automakers to simply continue with business as usual in Canada until as late as the 2016 model year.[25] Some of the CCS projects may not proceed, if their proponents decide they are not economically viable. The proposed regulations for coal-fired electricity will allow existing plants to operate for their full economic life (45 years) and will allow those new plants that plan to use CCS to avoid capturing the majority of their emissions until 2025. Under these regulations, about two-thirds of currently operating plants will not be required to meet the standard until after 2020, and nine will operate past 2030 without constraint.[26]

## Canadian targets could be met with no negative impact to job creation

While a far more significant federal commitment to manage oilsands GHG emissions would be required for Canada to meet its emissions target in 2020, a recent study[27] by M.K. Jaccard and Associates, a leading economic modelling firm, concluded that Canada could sharply reduce its emissions between 2010 and 2020 with only a slight slowing of economic growth, and with no negative impact on job creation. The study also showed that Canada could surpass the federal government's GHG target for 2020 while still expanding the oilsands industry and allowing Alberta to continue having the fastest growing economy in the country.[28] This would, however, require massive and urgent deployment of CCS in the oilsands.

### Canada is a climate follower, not a climate leader

Since the election of Barack Obama, the Government of Canada has consistently emphasized a commitment to harmonize its climate change action with that of the U.S.[29] Doubts over the Harper government's sincerity about this harmonization are fuelled however by Canada's failure to match its southern neighbour on key climate policies. In the 2010–2011 fiscal year, the Obama administration proposed 18 times more new spending on renewable energy, per capita, than the Government of Canada did.[30] The Obama administration also began regulating GHG emissions from some industrial facilities in January 2011, under the Clean Air Act, but Canada's federal government is still at the stage of talking about such regulations,[31] not implementing them. Even the proposed coal regulations that the Government of Canada published in August 2011 are not yet finalized and would not take effect until 2015. In the meantime, this leaves the oilsands sector without any federal GHG regulations or limits.

## Alberta's climate regulations are weak and will not counteract the growing GHG emissions from the oilsands sector

Alberta's climate plan can be called a car without an engine. It has many elements that could be effective, but without a meaningful price that penalizes $CO_2$ pollution, the car won't run and it won't get Alberta to its stated destination.

While the Alberta government makes bold claims[32] about its actions to curb GHG emissions, both its mid-term and long-term targets are weak relative to other jurisdictions and its actual performance has lagged. Over the mid-term, scientific consensus is that the world needs to reduce greenhouse gases by 25 to 40% below 1990 levels by 2020 to avoid dangerous climate change.[33] Many jurisdictions such as Ontario, U.K and Japan have made reduction commitments within this range. Alberta's 2008 climate plan, by contrast, assumes an approximate 40% growth in emissions between 1990 and 2020,[34] making it one of the few industrialized jurisdictions to commit to emissions increases rather than decreases. The 2008 plan also included a target to

reduce annual GHG emissions by 20 Mt below the business-as-usual level by 2010 — a target the province failed to even come close to meeting.

Over the long term, many industrialized (Annex 1 Parties) jurisdictions have committed to 70–80% reductions in GHG emissions by 2050. For example, the U.S. is targeting an 83% reduction below 2005 levels by 2050.[35] Alberta's long-term climate target is a mere 14% reduction below 2005 levels by 2050[36] thereby lagging significantly behind the ambitions of most other jurisdictions. While the Alberta plan commits to a number of specific policy actions, it makes no attempt to show that the policies will be strong enough to achieve the objectives.

In December 2011, Pembina completed the first and only comprehensive assessment[37] of Alberta's climate change plan. By assembling government and industry data we concluded that Alberta will miss its emissions reduction target by 2020 by two-thirds. The primary reason for this failure is that Alberta does not place a high enough price on pollution to incentivize the kinds of reductions it has committed to in its plan. The Alberta government's current GHG initiatives could result in at most about a 14 Mt reduction by 2020 compared to business-as-usual annual emissions; the reduction could possibly be less than 10 Mt by 2020.[38] This will fall far short of halting the growth in Alberta's GHG emissions, let alone achieving absolute reductions. An analysis of the key components of Alberta's climate change plan is provided below.

### *Specified Gas Emitters Regulation (SGER)*

This Alberta regulation requires all facilities emitting more than 100,000 tonnes of $CO_2$ equivalent per year to reduce average emissions intensities by 12% (for new facilities the requirement is phased in over several years).[39] These are, however, reductions on paper only, since facilities can comply by making payments of $15* per tonne $CO_2e$ into the Climate Change and Emissions Management Fund and by purchasing offset credits from projects in Alberta — credits that in many cases do not represent incremental emission reductions.

* All dollar amounts in this paper are in Canadian dollars.

While it is true that Alberta does have a price on carbon, this price is only applicable to 12% of the emissions from new large facilities, such as those being built in the oilsands. Furthermore, the $15/tonne compliance option essentially caps the price on carbon in the province at a rate far lower than the cost of achieving on-site reductions through CCS and other technologies, thereby failing to provide an incentive to implement those technologies.

### *Alberta's offset program*

Alberta's carbon offset program provides carbon credits to reductions made by projects that would already have taken place without any policy action. A Pembina Institute analysis of Alberta's offset registry revealed that more than 82% of credits used for compliance with the SGER during 2008 to 2010 came from projects that started before the policy was announced in 2007.[40] It is clear that the reductions associated with these projects cannot be attributed to the SGER and should not be awarded offset credits. Furthermore, offsets are largely reductions on paper only, diluting any real on-site GHG reductions achieved through the SGER.

### *Climate Change and Emissions Management Fund (CCEMF)*

As noted above, large emitters can make $15/tonne payments into Alberta's CCEMF to meet the Specified Gas Emitters Regulation intensity targets rather than making on-site emission reductions. The funds are reinvested in a wide range of emission reduction projects. In the period 2007 to 2010, $256 million was paid into the CCEMF;[41] to date $126 million has been committed to approved projects.[42] It is too early to know by how much these projects will reduce emissions. However, it is clear that the emission reductions in the near term (e.g., by 2020) will be much smaller than the "reductions" for which Alberta's large emitters are given credit by making payments into the CCEMF.

### *CCS subsidies*

Alberta has committed $2 billion to support large-scale CCS projects in the province, including two in the oilsands.[43] However, a recent proposal by the government to provide double offset credits for certain CCS projects may completely undermine any emission reductions made

under this program.[44] Even providing one credit for every tonne reduced would diminish the net emission reductions from CCS because each credit created allows the company receiving or purchasing that credit to emit an extra tonne (or avoid payments into the CCEMF). But when two credits are provided for every one tonne of reduction, the total allowed GHG emissions resulting from the CCS subsidies and offset system are higher still.

## Carbon capture and storage will not be deployed to reduce oilsands emissions in the absence of regulation

Much attention has been paid to the potential role that carbon capture and storage (CCS) could play in limiting GHG emissions from Canada's oilsands. This is partly because Alberta's climate change plan assumes that CCS alone will provide 139 Mt of a planned 200 Mt reduction (approximately 70%) from business as usual by 2050.[45] Yet often the attention understates both the slow and limited deployment of CCS and the significant challenges in applying this technology to the oilsands sector.

To date there are no operating CCS projects in the oilsands. One planned integrated project, Shell's Quest project, will capture 35% of the emissions from the Scotford Upgrader.[46] This project will receive $865 million in subsidies from the federal and provincial governments.[47] A second planned project, the Alberta Carbon Trunk Line, proposes to transport $CO_2$ from an oilsands upgrader and other industrial facilities in central Alberta to oil fields for enhanced oil recovery.[48] At $558 million, federal and provincial subsidies will cover 47% of this project's costs.[49]

While in principle CCS could be applied at several different stages in the bitumen extraction and upgrading phases, the cost of capturing emissions from many of the sources is likely to be prohibitive unless governments are willing to implement carbon prices an order of magnitude higher than they have contemplated to date. In general, $CO_2$ emissions associated with hydrogen production at oilsands upgraders have relatively lower capture costs, estimated at

$75 to $155/tonne.[50] These costs are within the range of other relatively low-cost capture sources like coal-fired electricity production and oil refining. However, $CO_2$ streams from in situ oilsands have among the highest capture costs, estimated at $175 to $230/tonne.[51]

In Alberta, the effective carbon price is set at $15/tonne of $CO_2$ At this price level, and in the absence of further massive public subsidies, there is very little (if any) financial incentive for oilsands producers to pursue CCS projects.

IHS CERA noted that capturing $CO_2$ at upgraders presents the best opportunity for CCS implementation in the oilsands and could lead to a net decrease in emissions intensities of 11 to 14% for bitumen production and upgrading (well-to-tank).[52] According to the forecast scenario described in the report, CCS implementation in the oilsands will begin around 2020 and, as it expands, will lead to industry-wide GHG reductions of approximately 6 Mt from business as usual by 2035.[53] While CCS reductions may occur within other industries, at this rate Alberta will be required to substantially increase their implementation of CCS to achieve the target of 139 Mt of carbon capture and storage by 2050.

Unfortunately, Alberta's climate plan states that 30 MT of annual reductions will be derived by CCS by 2020 — the equivalent of building 25 Quest-type projects in the next eight years. Clearly, this is a fiction.

In its 2010 World Energy Outlook the International Energy Agency modelled a "450 Scenario" to project energy supply and demand that would be consistent with stabilizing atmospheric GHG concentrations at 450 parts per million of carbon dioxide. This scenario projects that oilsands production would continue to grow although much more slowly than current growth projections, with production reaching just over 3 million barrels per day (mbpd) of production in 2035.[54] In other words, under this scenario Canada can have an oilsands industry, a carbon price and meet international climate targets.

Pembina has also conducted economic modelling that examines the fate of the oilsands in a regulatory environment where Canada meets its international commitments or science-based targets to reduce greenhouse gas pollution.[55] Both scenarios required mandatory CCS and resulted in a slowing of oilsands expansion.

The current unchecked rate of oilsands development is a symptom of Canada's failure to regulate greenhouse gas pollution, and it appears that rosy industry projections for oilsands expansion are mathematically inconsistent with North America's stated commitments to reduce greenhouse gas pollution.

## Limited policy signals to drive innovation

Currently there are few strong policy signals to improve environmental management in the oilsands. As described above, the existing climate regulations are inadequate to spur the innovation necessary to reduce either emissions intensity or absolute greenhouse gas emissions.

In the absence of adequate environment policies, several leading oilsands companies have created their own initiatives. The recently-announced Canadian Oil Sands Innovation Alliance, a new and larger version of the older Oil Sands Leadership Initiative, is a partnership of 12 oilsands companies that intend to share experience and intellectual property amongst themselves. While these sorts of initiatives are a step forward, they are unlikely to result in meaningful improvements in environmental performance unless there are policy or price signals to compel companies to innovate.

As well, if clear policy signals were given to other aspects of the oilsands industry such as water and species at risk management, land impacts and reclamation, these signals would likely catalyze the necessary innovation to mitigate impacts and temper international scrutiny of the oilsands.

## Pace and scale issues not solved by technology

The Canadian Association of Petroleum Producers predicts that oilsands production will double from 1.5 mpbd in 2010 to 3.0 mbpd by 2020, to over 3.73 mbpd by 2025 (Figure 5). If the oilsands production is forecasted by development stage, already over 4 mpbd in production capacity has received all the necessary regulatory approvals. If one also considers the projects

that are in application or have been disclosed or announced, then the potential nameplate capacity for the oilsands rises to over 8.1 mbpd (Figure 6).[56]

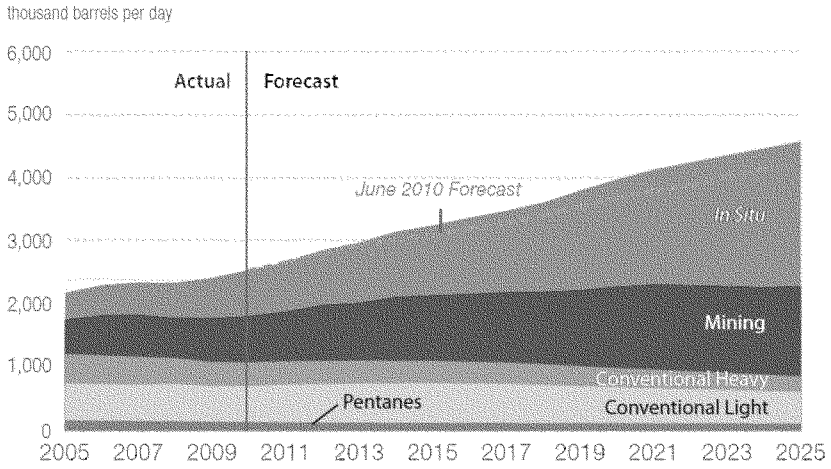


**Figure 5. Projected oilsands growth, 2011 to 2025**

Source: Canadian Association of Petroleum Producers, 2011-2025 Crude Oil Forecast, Markets & Pipeline Report

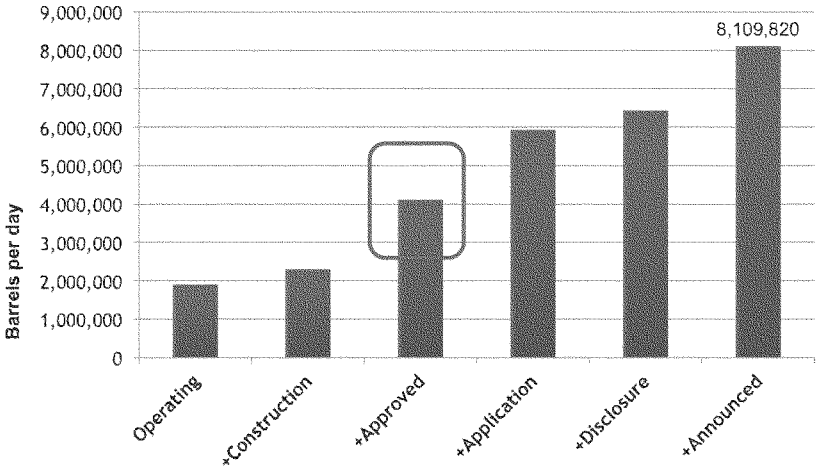


**Figure 6. Projected oilsands capacity by development stage**

Source: Dunbar, R. *Existing and Proposed Canadian Commercial Oil Sands Projects January 2011*. Strategy West, Calgary, AB, 2011.

Based on these production forecasts, any incremental gains made by technological innovation will would be be overshadowed by the absolute increases in impacts caused by the entire industry. This was demonstrated earlier by the absolute increases in GHG emissions despite a 29% reduction in GHG intensity between 1990 and 2009.

While Pembina Institute is supportive of voluntary measures and research and development by the oilsands industry, it is important to distinguish among lab research, small-scale pilot projects and commercial penetration of new technologies. The vast majority of approved and proposed oilsands projects under development are traditional mines and in situ projects with traditional environmental impacts. Given the long life span of oilsands projects, the current rush to approve projects using existing technologies actually undermines the ability to deploy innovative technologies in the future.

# Stronger regulatory environment needed to drive technological innovation

As demonstrated by historical achievements with acid rain, chlorofluorocarbons and leaded gasoline, a stronger regulatory environment facilitates technological innovation. In a comparatively marginal economic oil play like the oilsands, any additional costs on environmental improvements or research and development reduces the profitability of a company's producing oilsands assets. As a result, there can be an economic penalty for companies that undertake additional risks and seek to innovate. Clear regulations allow the environmental performance of the entire industry to improve and remain competitive in the international marketplace.

## Market signals also create innovation

The market signals provided by regulations, like California's Low Carbon Fuel Standard, are critical to spurring innovation in the oilsands. As absolute and intensity-based GHG emissions continue to rise in the oilsands, it is clear that this fuel standard has caught the attention of oilsands producers. Clear market signals like those provided by fuel standards will likely provide the economic rationale to drive further innovation.

## Land planning and thresholds are essential to addressing environmental impact

Beyond greenhouse gas management in the oilsands, land use planning that monitors and manages the cumulative impacts from oilsands development is also a critical policy to drive stronger environmental performance. The Alberta government is in the process of approving a regional land use plan for the oilsands region. The implementation of this plan creates an opportune policy window for substantive reform of how the region is managed. The Pembina Institute has produced a report that presents 19 policy recommendations that can mitigate the environmental impact of the oilsands and drive technological innovation.[57]

**Endnotes**

[1] Oilsands emissions have grown from 17 Mt in 1990 to 45 Mt in 2009. Source: Environment Canada, *National Inventory Report - Part 1 1990-2008 Greenhouse Gas Sources and Sinks in Canada* (2010) 86, Table 2-16. http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=492D914C-2EAB-47AB-A045-C62B2CDACC29 Note: the value for 2009 oilsands total emissions was provided in e-mail communication from Environment Canada officials.

[2] Environment Canada, *Canada's Emissions Trends* (2011) 25, Table 5. http://www.ec.gc.ca/Publications/E197D5E7-1AE3-4A06-B4FC-CB74EAAAA60F/CanadasEmissionsTrends.pdf

[3] Environment Canada, *National Inventory Report - Part 1* (2010) 86, Table 2-16. Note: the value for 2009 oilsands total emissions was provided in e-mail communication from Environment Canada officials.

[4] Environment Canada, *Canada's Emissions Trends* (2011) 25, Table 5.

[5] Ibid.

[6] Calculated using an average value of 111 kg of $CO_2$ equivalent emissions for producing one barrel of synthetic crude oil from oilsands. The GHG emissions from individual projects vary considerably because of differences in technologies, practices and oilsands quality from project to project. Average emissions per barrel for conventional crude oil production are 35.2 kg of $CO_2$ equivalent in Canada and 24.5 kg of $CO_2$ equivalent in the U.S. Source: National Energy Technology Laboratory, *Development of Baseline Data and Analysis of Life Cycle Greenhouse Gas Emissions of Petroleum-Based Fuels* (2008) 12, Table 2-5.

[7] Pierre Gosselin, Steve E. Hrudey, M. Anne Naeth, André Plourde, René T Errien, Glen Van Der Kraak, and Zhenghe Xu, *The Royal Society of Canada Expert Panel: Environmental and Health Impacts of Canada's Oil Sands Industry* (2010) 92-93. http://www.rsc-src.ca/documents/expert/RSC report complete secured 9Mb.pdf.

[8] See Figure 3 [source provided in footnote to figure caption]

[9] Note: due to revisions of historical data made by Environment Canada, intensity improvements are 29% rather than the 39% figure that was previously cited widely.

[10] Petroleum coke is a very carbon-intensive fossil fuel compared to natural gas.

[11] IHS CERA, *Oil Sands Technology: Past, Present, and Future (Special Report)* (2011) 9. http://www2.cera.com/cos_form/.

[12] For more information, refer to: Danielle Droitsch, Marc Huot, and P.J. Partington, *Canadian Oil Sands and Greenhouse Gas Emissions: The Facts in Perspective* (Pembina Institute, 2010). http://www.oilsandswatch.org/pub/2057

[13] IHS CERA, "Summary of Key Insights of IHS CERA's Analysis," *Oil Sands Technology: Past, Present, and Future (Special Report).* 2011.

[14] Environment Canada, *National Inventory Report - Part 1* (2010) 86, Table 2-16. Note: the value for 2009 oilsands total emissions was provided in e-mail communication from Environment Canada officials.

[15] Statistics Canada, Table 126-0001 - Supply and disposition of crude oil and equivalent, monthly (cubic metres), CANSIM database. Accessed July 22, 2010.

[16] Gosselin, et al, *The Royal Society of Canada Expert Panel,* 89.

[17] Based on 2007 operational data. Source: Marc Huot and Simon Dyer, *Mining vs In Situ Factsheet* (Pembina Institute, 2010). http://www.oilsandswatch.org/pub/2017.

[18] Ibid.

[19] Rebecca Rooney, Suzanne Bayley, and David Schindler, "Oil sands mining and reclamation cause massive loss of peatland and stored carbon," *Proceedings of the National Academy of Sciences*, (2012) published online before print March 12, 2012.

[20] This pledge has been inscribed in the Copenhagen Accord but with the caveat that it may change based on developments in the U.S. *Copenhagen Accord: Appendix I - Quantified economy-wide emissions targets for 2020, Annex I parties: Canada.*
http://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/canadacphaccord_app1.pdf

[21] Environment Canada, *Canada's Emissions Trends,* 22, Table 3; Environment Canada, *A Climate Change Plan for the Purposes of the Kyoto Protocol Implementation Act* (2011).
http://www.climatechange.gc.ca/Content/4/0/4/4044AEA7-3ED0-4897-A73E-D11C62D954FD/COM1410_KPIA%202011_e%20-%20May%2031%20v2.pdf

[22] Note: It could be argued that federal emission ]reduction efforts only need to be increased fourfold, because the 32.5 Mt impact of current federal policies in 2020 needs to be increased to 32.5+89=121.5 Mt to meet Canada's target (see the numbers at the right-hand side of Figure 4). But to make a fair comparison of the effort entailed in two sets of policies, it is important to compare their impact on emissions over similar time periods. This is because policies generally have a bigger impact on emissions over a longer time period, without any extra effort by government (the key government effort is at the beginning in getting the policies adopted and implemented). Current federal policies that have not yet begun to impact emissions are recognized in our tenfold calculation because they shrink the emission-reduction effort needed in the 2013–20 period.

[23] Environment Canada, *Canada's Emissions Trends,* 22, Table 3.

[24] Ibid., 25, Table 5.

[25] Matthew Bramley and P.J. Partington, *Pembina Institute Comments on Canada's Proposed Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations,* (Pembina Institute, 2010).
http://www.pembina.org/pub/2055.

[26] The Pembina Institute, "Pembina reacts to new federal regulations for coal-fired electricity," news release, August 19, 2011. http://www.pembina.org/media-release/2255

[27] M. K. Jaccard and Associates Inc., *Exploration of two Canadian greenhouse gas emissions targets: 25% below 1990 and 20% below 2006 levels by 2020* (Prepared for the David Suzuki Foundation and the Pembina Institute, 2009). http://www.pembina.org/pub/1910.

[28] Matthew Bramley, Pierre Sadik and Dale Marshall, *Climate Leadership, Economic Prosperity: Final Report on an Economic Study of Greenhouse Gas Targets and Policies for Canada* (The Pembina Institute and the David Suzuki Foundation, 2009). http://www.pembina.org/pub/1909.

[29] For example, when signing the Copenhagen Accord, the federal government announced "The Government of Canada has consistently emphasized the importance of harmonizing our approach to climate change with that of the United States." Source: Office of the Minister of the Environment, "Canada Lists Emissions Target under the

Copenhagen Accord," news release, February 2010. http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=EAF552A3-D287-4AC0-ACB8-A6FEA697ACD6

[30] Tim Weis, *Comparing U.S. and Canadian investments in sustainable energy in 2010* (The Pembina Institute, 2010). http://www.pembina.org/pub/1979.

[31] Federal regulations are expected out within the next year for the oil and gas sector; regulations for other sectors may follow.

[32] According to provincial Environment Minister Rob Renner, "We're taking tremendous steps forward on climate change. We're setting achievable targets and laying out ways we will get there. The world is looking for leadership on climate change. The opportunity is there for the taking. Alberta is taking it." From Rob Renner, "Climate Change" (speech in Washington, DC, March 30, 2009). Available at http://environment.alberta.ca/documents/Climate-Change-Was-NY-speech-Mar-30-31-2009.pdf.

[33] Matthew Bramley, *The Case for Deep Reductions: Canada's Role in Preventing Dangerous Climate Change* (Pembina Institute and David Suzuki Foundation, 2005) http://www.pembina.org/pub/536

[34] Alberta's emissions in 1990 were 177 Mt. Source: *National Inventory Report 1990–2009: Greenhouse Gas Sources and Sinks in Canada*, Part 3, 95.

Alberta's plan assumes emissions grow to approximately 250Mt in 2020. As interpreted from the Figure on page 24 of Alberta's 2008 plan. Source: Alberta Environment, *Alberta's 2008 Climate Change Strategy: Responsibility / Leadership / Action* (2008). http://environment.gov.ab.ca/info/library/7894.pdf

[35] Copenhagen Accord, Appendix I - Quantified economy-wide emissions targets for 2020 – United States (United States Department of State, Office of the Special Envoy for Climate Change, 2010). Available at: http://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/unitedstatescphaccord_app.1.pdf

[36] Alberta Environment, *Alberta's 2008 Climate Change Strategy: Responsibility / Leadership / Action* (2008). http://environment.gov.ab.ca/info/library/7894.pdf

[37] Matthew Bramley, Marc Huot, Simon Dyer and Matt Horne, *Responsible Action? An assessment of Alberta's greenhouse gas policies* (Pembina Institute, 2011). http://pubs.pembina.org/reports/responsible-action.pdf

[38] Ibid.

[39] Government of Alberta, Specified Gas Emitters Regulation, available at http://www.qp.alberta.ca/574.cfm?page=2007_139.cfm&leg_type=Regs&isbncln=9780779758791&display=html.

[40] Calculation by the authors based on an analysis of data publicly available at http://www.carbonoffsetsolutions.ca/acor/. Further details in *Responsible Action? An assessment of Alberta's greenhouse gas policies.*

[41] Alberta Environment, "Greenhouse Gas Reduction Program." Accessed August 17, 2011. http://environment.alberta.ca/01838.html.

[42] Climate Change Emissions Management Corporation, "Funded Projects." Accessed August 17, 2011. http://cecmc.ca/funded-projects.

[43] Government of Alberta, "Carbon Capture and Storage: Major Initiatives." Accessed August 29, 2011. http://www.energy.alberta.ca/Initiatives/1897.asp

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[44] Chris Severson-Baker, "Bonus credits for CCS weaken Alberta's greenhouse gas regulations," *The Pembina Institute*, blog post June 4, 2011. http://www.pembina.org/blog/552

[45] Alberta Environment, *Alberta's 2008 Climate Change Strategy: Responsibility / Leadership / Action* (2008). http://environment.gov.ab.ca/info/library/7894.pdf

[46] Shell Canada, "Oilsands: Shell's Quest." Accessed March 1, 2011. http://www.shell.ca/home/content/can-en/aboutshell/our_business/business_in_canada/upstream/oil_sands/quest/

[47] The Alberta government will provide $745 million and the Canadian government will provide $120 million. Source: Shell Canada, "Shell, governments agree funding for Canadian $CO_2$ storage project," news release June 24, 2011. http://www.shell.ca/home/content/can-en/aboutshell/media_centre/news_and_media_releases/2011/0624ccs.html

[48] Initial design will transport 4,600 to 5,100 tonnes of $CO_2$ per day from two sites: the North West Upgrading Inc. oilsands upgrader and Agrium Inc. Redwater complex. Source: Enhance Energy Inc., "Alberta Carbon Trunk Line," 2010. Accessed March 1, 2011. http://www.enhanceenergy.com/co2_pipeline/index.html

[49] Enhance Energy, Inc., "Alberta Carbon Trunk Line, Q & A." Accessed September 5, 2011. http://www.enhanceenergy.com/q_a

[50] $CO_2$ capture from coal power generation is the lowest cost at $60–130 per tonne. Source: Delphi Group, *2009 ICO2N Alternatives Report,* Table 2.4-2: http://delphi.ca/images/uploads/IC02N_GHG_Alternatives_Report.pdf

[51] Ibid.

[52] The net intensity decrease is based on a 40% reduction for the upgrading portion of the synthetic crude production but also takes into consideration a 30% loss of efficiency that results from adding $CO_2$ capture to an upgrader. Source: IHS CERA, *Oil Sands Technology: Past, Present, and Future,* 20.

[53] The Scenario forecasts 30% reductions (approximately 18 Mt), one third of which resulting from CCS. *Oil Sands Technology: Past, Present, and Future,* 31-32, Figure 10.

[54] International Energy Agency, *World Energy Outlook 2010*, (2010), 450.

[55] *Climate Leadership, Economic Prosperity.*

[56] Strategy West 2011 Outlook

[57] Simon Dyer, Jennifer Grant, Marc Huot and Danielle Droitsch, *Solving the Puzzle: Environmental responsibility in oilsands development* (Pembina Institute, 2011)

Mr. WHITFIELD. And thank you, Mr. Dyer.
And Ms. Laboucan-Massimo, you are recognized for 5 minutes.

**STATEMENT OF MELINA LABOUCAN–MASSIMO**

Ms. LABOUCAN-MASSIMO. Thank you. Good morning, chair and committee. My name is Melina Laboucan-Massimo. I come from northern Alberta, Canada. I am a member of the Lubicon Cree First Nation, which is one of the many communities impacted by tar sands development.

For those of us in Canada who are experiencing the detrimental effects of tar sands, it is encouraging to see that many decision-makers and citizens in the United States are beginning to ask questions around whether or not the tar sands are in the right direction and which we should be pursuing in an already carbon-constrained world. In the past 5 years, I have worked in communities throughout Albert and British Columbia that are very concerned about the approval of tar sands pipelines not only because of potential spills but also because it will increase pressure for more tar sands expansion in Alberta.

I personally have felt the impacts of both pipeline spills and tar sands-driven industrialization of the landscape in the north. Last spring, I returned home where I was born to witness the aftermath of one of the largest spills in Alberta's history, which was 50 percent larger than the oil spill in the Kalamazoo River in Michigan. What I saw was a landscape forever changed where my family fished, hunted, and trapped for generations. Days before the Federal or provincial government admitted that this had happened, my family was sending me messages telling me of headaches, burning eyes, nausea, and dizziness, asking me if I could find out more information as to if it was an oil spill and how big it might be. This was one of the saddest and most frustrating points because my family was not the first, nor the last, to experience these effects. It was alarming to hear that the first phase of the Keystone had already leaked and spilled 14 different times in its first 12 months of operation.

Where I come from billions of dollars are taken out of our traditional territories. Yet, until this day, my family still has no running water. The indigenous communities have lived in these regions for thousands of years and yet are being pushed out, unable to access their traditional territories and unable to practice their treaty rights due to tar sands expansion. This is a violation of our constitutionally protected rights under Section 35 of the Canadian Constitution.

Communities like Fort McKay First Nation can no longer drink the water from their taps and their children are developing skin rashes from bathing in this contaminated water. A cancer study done by Alberta Health Services reveal that there was a 30 percent increase in the community downstream of Fort Chipewyan. Leukemias and lymphomas were increased by three-fold and bile duct cancers increased by seven-fold. Almost all of the cancer types that were elevated were linked in scientific literature to chemicals in oil or tar. We have toxic tailing ponds sitting in the north of Alberta that span over 170 square kilometers, which is equivalent to 42,000 acres.

This is the reality in Canada. And more specifically, in Alberta, we have a lax and failing environmental monitor system, which has little to no enforcement when it comes to the tar sands. There have been thousands of alleged contraventions, notifications, and releases with little to no evidence of enforcement as see in a database from Alberta Environment Documents, which details incidences of licensed and unlicensed discharges of pollutants, tailing leaks, chronic acute pollution incidents, habitat destruction, and failure by industry to maintain monitoring equipment, pollution and government documentation of reclamation and chronic lack of enforcements.

We have endured decades of promises that have taught us that promises of new technologies that will repair this damage feel like empty words. The reality is that SAGD solutions usually move the problem elsewhere such as pumping the toxic byproduct underground where they can leak into aquifers rather than storing them in tailing ponds from the mines. Meanwhile, the scale of production is increasing and the overall programs are getting worse. We have not yet seen a cumulative environmental assessment overall in the tar sands and the government is therefore passing these projects without this cumulative environmental assessment.

Companies will leave irreparable damage to our lands and our homes, and the Alberta government claims to reclaim the land. However, many prominent scientists dispute that this is possible. Just last week, a report was published in the proceedings of the National Academy of the Sciences of the United States of America stating "any suggestion that oil sands reclamation will put things back to the way they were is greenwashing."

First Nations in British Columbia are also adamant that the Enbridge pipeline will not be built through their territories. Over 100 First Nations have signed on to this declaration to oppose the construction of the Enbridge pipeline and its associated supertankers on the west coast of Canada and First Nations are willing to pursue litigation if the Enbridge pipeline is approved in Canada as they have constitutionally protected rights under Section 35 of the Canadian Constitution.

If constructed, the Keystone XL would deepen our mutual addiction to dirty oil and enable the ongoing expansion of the tar sands at the expense of communities, as well as at the expense of advancing cleaner energy alternatives. You have a choice in the direction we are taking in the world. You have the opportunity to become the world leaders in clean renewable energy solution that meet our energy needs without undermining or sacrificing the health of our communities and ecosystems.

Thank you very much.

[The prepared statement of Ms. Laboucan-Massimo follows:]

# Testimony of Melina Laboucan-Massimo

**House Committee on Energy and Commerce—Subcommittee on Energy and Power**
**March 20, 2012**

Thank you for inviting me to be here today.

My name is Melina Laboucan-Massimo. I come from Northern Alberta, Canada. I am a member of the Lubicon Cree First Nation, which is one of the many communities who are feeling the brunt of intense fossil fuel development due tar sands expansion. In the past 5 years I have worked with other communities in Northern Alberta and British Columbia that are very concerned about the approval of new tar sands pipelines due to potential spills, but also because it will increase pressure for more tar sands expansion in Alberta.

For those of us in Canada who are experiencing the detrimental effects of the Alberta Tar Sands, it is encouraging to see that many decision-makers and citizens in the United States are beginning to ask questions around whether or not the tar sands are the right direction we should be pursuing in an already carbon constrained world. We are particularly concerned about the looming threat of the expansion that would be enabled by the Keystone XL pipeline because, despite what you may have heard, the other proposed tar sands pipelines through British Columbia will not be built soon or ever. This is because even if they are approved, they will likely be tied up in the courts for many years due to constitutional challenges from affected First Nations, who have a unique legal status within the Canadian constitution.

I have personally felt the impacts of both pipeline spills, and the tar sands-driven industrialization of the landscape.

Last spring I returned home to where I was born to witness the aftermath of one of the largest oil spills in Alberta's history. What I saw was a landscape forever changed by oil that had consumed a vast stretch of the traditional territory where my family had once hunted, trapped and picked berries and medicines for generations. Days before the federal or provincial government admitted that this had happened my family was sending me text messages telling me of headaches, burning eyes, nausea and dizziness asking me if I could find out more information as to if it was an oil spill and how big it might be. This oil spill was from a multi-use pipeline which carried tar sands oil, sweet light crude as well as condensate. Due to the corrosive nature of tar sands oil it is no surprise that this was not the first major spill from this pipeline. In 2006 more than 1 million litres (7,500 barrels) was spilled and according to the Alberta Energy and Utilities Board (EUB), "stress corrosion cracking and external coating failure caused the release."[1]

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[1] http://www.ercb.ca/docs/new/newsrel/2007/nr2007-14.pdf

It wasn't until the day after the federal election that the information was released of the magnitude of the spill – 28, 000 barrels or 4.5 million litres of oil had soaked the land – this is 50 per cent larger than the tar sands oil spill in the Kalamazoo River in Michigan the year before.

Soon afterward the story was swept under the carpet away from the eyes of the public yet it took until the end of the year for the official clean up to be done, but just like in Michigan we know that the land and water in that area will never be the same.

One of the saddest and most frustrating points about this is that my family has not been the first nor will it be the last to experience this terrifying and intense situation when an oil spill happens nearby. We have seen a oil spills happen all over North America like the 12 leaks from the first phase of the Keystone during its first year of operation.

Despite the fact that Canada prides itself on being a free and democratic society where local communities are respected and environmental regulations are superior to most nations - the sad fact is that Canada is from far from it.

In reality Canada and more specifically the province of Alberta have a lax and failing environmental monitoring system with little enforcement for its own laws when it comes to producing the tar sands.

RAMP - The Regional Aquatics Monitoring Program, which is supposed to help monitor the oil sands region has been called incompetent. As early as 2004, a scientific peer review of the program "raised significant concerns about the Program itself. They felt there was a serious problem related to scientific leadership, that individual components of the plan seemed to be designed, operated and analyzed independent of other components, that there was no overall regional plan, that clear questions were not being addressed in the monitoring and that there were significant shortfalls with respect to statistical design of the individual components."[2]

It was only after scathing criticism of RAMP was published in scientific journals and received extensive media coverage that both the federal and provincial governments appointed review panels, which found that RAMP was, in essence, designed to fail when it came to measuring and assessing environmental change.

When companies violate environmental regulations we rarely hear of these companies being prosecuted. There have been thousands of 'alleged contraventions', notifications, and releases with little or no evidence of enforcement as seen in a database compiled

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[2] G. Burton Ayles, Monique Dube and David Rosenberg, Oil Sands Regional Aquatic Monitoring Program (RAMP) Scientific Peer Review of the Five Year Report (1997-2001). Submitted to: RAMP Steering Committee February 13, 2004.

by Dr. Kevin Timoney which lists thousands of pollution-related "incidents" in the tar sands.[3]

The evidence is compiled in the database is information that was accessed from Alberta Environment documents which detail thousands of incidences from licensed and unlicensed discharges of pollutants, tailings pond leaks, chronic pollution, acute pollution incidents, habitat destruction, failure by industry to maintain pollution monitoring equipment, poor government and industry documentation of reclamation, and a chronic lack of enforcement by government.

For example, Alberta Ambient Air Quality Objectives were exceeded 1,556 times in 2009 which is significantly more than the 47 times exceedances were recorded in 2004.

The government of Alberta actually allows industry to self-report. In this system where there is no independent third party stringently regulating, we have often found that profit takes precedence over environmental integrity of the area, and the situation in Alberta is one where our pristine ecosystems are being highly compromised.

For decades, we have been told that new technology will solve these environmental problems. But the reality has been that they usually just move the problem around, like pumping toxic waters underground where they can slowly leak into aquifers rather than storing them in ponds where they leak into rivers and streams. Or how in situ production avoids open pit mining, but fragments an equivalent amount of habitat while resulting in much higher greenhouse gas emissions.

Meanwhile, the scale of production keeps increasing and the overall problem gets worse.

We are in desperate need of a cumulative environmental assessment of the region as this has not been done despite tar sands projects being in operation for over 40 years. Despite claims by companies that they will "reclaim" the land that they disturb, we have seen very little reclaimed in the region.

Companies will leave irreparable irreversible damage to the land and our homes. The Alberta government claims otherwise, vowing to "reclaim" the land – however, many prominent scientists dispute that this is even possible. As of December 2010, only 0.15% of the land devastated by tar sands mining operations has been certified as reclaimed. The Proceedings of the National Academies of Sciences of the United States of America published research just last week stating that "companies have **no obligation** to restore or compensate for the destroyed wetlands" and "any suggestion that oil sands reclamation will put things back the way they were is **greenwashing.**"[4]

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[3] ftp://globalforestwatch.ca/PublicFTP/TarSandsEnvImpacts/

[4] http://www.pnas.org/content/early/2012/03/06/1117693108.full.pdf+html?with-ds=yes

The building of the Keystone XL will not only increase tar sands expansion but it will exacerbate the problems we are already seeing in the tar sands. There are First Nation communities in Alberta that are challenging tar sands expansion in the courts namely the Beaver Lake Cree First Nation and Athabasca Chipewyan First Nation. The Beaver Lake Cree is currently challenging the Canadian and Alberta government for infringing on their treaty rights in regards to tar sands projects and its associated infrastructure. The Athabasca Chipewyan First Nation is currently suing Shell and will also be challenging the approval of the Pierre River mine in the courts as well.

First Nations in British Columbia are adamant about not allowing the Enbridge pipeline through their traditional territories. Over 100 First Nations have signed onto a declaration to oppose the construction of the Enbridge pipeline and the associated super tankers on the west coast.

First Nations also are willing to pursue litigation if the Enbridge pipeline is approved in Canada as they have constitutionally protected rights under section 35 which protect inherent Aboriginal and Treaty Rights.

First Nations are not the only ones to oppose this pipeline. In British Columbia, surveys show that 80% of British Columbians oppose super tankers on the Pacific West Coast. Many people do not think the pipeline or super tankers will benefit the province of BC especially with a thriving fishing and eco-tourism economy, which brings in over $1 Billion dollars to BC annually.

Where I come from billions of dollars have come out of our traditional territory yet to this day my family has no running water. The Indigenous communities that have lived in these areas for generations upon generations are being pushed out and unable to practice their treaty rights, which are constitutionally recognized in Canadian law.

These rights are not being respected nor protected. It is becoming more and more difficult to harvest sacred traditional medicines from the muskeg or pick berries in the forests - for the living and breathing ecosystems that my ancestors lived on sustainably for thousands of years will be lost if we continue down this path.

We see abject poverty in the richest province in the country. First Nation communities are living in third world conditions while they live in the midst of a first world county. We see Aboriginal and Treaty Rights being violated in the name of the tar sands which are enshrined in the Canadian Constitution itself under Section 35.

Tar Sands expansion will eventually drive out much of the remaining wildlife in the area that has not already been affected by In Situ projects or the massive open pit mines that are the size of entire cities. In my lifetime I will witness animal species go extinct in the tar sands. The woodland caribou, a food source that First Nations have used for

millennia are projected to go extinct by 2040. And not only is wildlife being driven out and declining in population but it is become a contaminated food source for local communities.

As we see the landscape change, my father who is a Cree hunter has more and more difficulty in finding moose to feed our family and community. A couple of years ago, he found 3 tumours in the carcass of a moose while hunting in our traditional territory.

Pristine forest, wetlands, bogs and fens are torn up and destroyed which will be replaced by acidic soil, end cap lakes and tree farms – a mere shadow of what once was.

Currently we have toxic tailing ponds sitting on the land in northern Alberta that span over 170 square kilometers which is equivalent to 42,000 acres – this is not including the toxic waste that is produced by In Situ projects which are either injected back into the earth or taken away to sit in landfills.

These tailing ponds contain a whole slew of toxic chemicals from arsenic, cyanide, mercury, lead, benzene, ammonia, polycyclic aromatic hydrocarbon and naphthenic acids some of which are known carcinogens.

These tailing ponds are leeching into the Athabasca watershed. It has been estimated that every day over 11 million litres or almost 3 million gallons leeched into the watershed.

It is therefore no wonder that communities are reporting the changes they are seeing to the water, fish and the health in their communities.

Last week I was visiting the community of Fort McKay, which is completely surrounded by tar sands mines and in situ projects. They have been advised NOT to drink water or cook with the tap water or take long showers. Children are developing sores on their bodies from exposure to the water they have to bathe in. The First Nation has had to cart bottled water in from Fort McMurray for community members, which is just under an hour's drive away.

Communities are also pulling mutated fish with tumours and boils on them out of the various rivers and lakes in the region and unable to consumed these as a part of their diet.

We are also seeing elevated rates of cancers in the north of Alberta. I myself have had family members live and die with cancer. And we are also seeing increased rates of respiratory illnesses such as emphysema, asthma, and chronic pulmonary disease due to the increased level of sulfur dioxide, and hydrogen sulfide.

A cancer study done by Alberta Health Services revealed that there was a 30% increase in cancers in Fort Chipewyan compared with expected over the last 12 years. Leukemias and lymphomas increased by 3-fold and Bile duct cancers increased by 7-fold and other cancers such as soft tissue sarcomas, and lung cancers were elevated. Almost all of the cancer types that were elevated have been linked scientifically to chemicals in oil or tar.

These types of cancers have also been linked in scientific literature to petroleum products, including VOCs, dioxin-like chemicals, other hydrocarbons, and PAHs which are chemicals found in tar and soot.

We need a safer energy future for both Canada and the United States which is why it is utterly essential that US decision-makers look carefully at the impacts I have mentioned, as the Keystone XL will not only create more expansion of the tar sands but this expansion will continue to exacerbate the devastating effects we are already feeling in communities impacted by the tar sands.

Extracting oil from the tar sands is one of the most expensive and most environmentally destructive ways to produce oil in the world. While open pit mines are more visually horrifying, SAGD is far more carbon-intensive, water-intensive, and energy-intensive, which will be 80% of the way tar sands will be produced.

Continuing to produce this type of fossil fuel in an already carbon distraught world - is essentially carbon suicide. Not only are we producing C02 emissions at an unsustainable rate, but we are also fragmenting and destroying one of the last intact boreal forests in the world that helps us to keep carbon in check. And this is the path that the Harper government wants to keep us on for the next 50 to 100 years.

We have a choice to change the direction we are taking in the world. We could become world leaders in the clean, renewable energy solutions that meet our energy needs without undermining the health of our communities and ecosystems.

We won't get there, however, if we try to attach technofixes onto what is, at every stage, a profoundly destructive form of energy.

The reality is that the tar sands are managed to maximize profits, and not to protect the environment or downstream communities like the one where my family lives. We have endured decades of broken promises, which has taught us that corporate promises of new technologies that will repair this damage are simply empty words – greenwash – intended to reassure people like yourselves that this time it will be different.

The truth is that the result won't change as long as we focus our ingenuity and investment in scraping the bottom of the barrel in a world that is running low on conventional oil. If constructed, the Keystone XL would deepen our mutual addiction to

dirty oil and enable the ongoing expansion of the tar sands at the expense of cleaner alternatives.

I urge you to look beyond what is good for the oil companies' next few quarterly profits, and think about what is in the best interest of the next generation.

Thank you.

Mr. WHITFIELD. Thank you very much. And thank all of you for your thoughtful testimony.

And at this time we will have periods of questions for the panel and I will recognize myself for 5 minutes, and then we will go to the other members.

First of all, Mr. Smith, you were the minister of energy in Canada for a number of years, is that correct?

Mr. SMITH. That is correct. I was the minister of energy for the Province of Alberta, which owns the resource and manages it on behalf of all Albertans.

Mr. WHITFIELD. And how would you describe the government of Alberta's approach to leasing land for oil sands development?

Mr. SMITH. What happens, Mr. Chairman, is that if there is no record of development after a lease has been purchased in an open auction type of format, then that lease reverts back to the Crown and it is in fact resold. So that way it is a clear process, it is a transparent process, and it is one that has been free from corruption for the last 70 years that it has been in place.

Mr. WHITFIELD. Well, would you characterize Alberta as being encouraging development or being an obstacle to development?

Mr. SMITH. Well, I don't think the government that I was involved with, Mr. Chairman, made any secret out of wanting to generate employment and create jobs and create prosperity and wealth for the Province of Alberta. That province, at the time I was elected at 2.5 million now has 3.7 million people. It has consistently the lowest unemployment across Canada, consistently the highest average earnings. The oil sands itself has created more jobs for aboriginal and First Nations people in Canada than any other place in Canada today.

The oil sands fall under three areas of the government—regulator, policymaker, and royalty collector. So you are always in a dynamic tension of dealing with those three matters. They are making great progress. I have seen reclamation of mined sites, Mr. Chairman, where the company went to the elders of the First Nations, they asked what would they like in reclamation, and in fact they created a buffalo herd. That buffalo herd that is on there today has a herd of about 300 with a 99 percent successful calving rate.

Mr. WHITFIELD. So if I describe the Alberta area as having an economic boom since this took place, would that be accurate or not?

Mr. SMITH. Absolutely.

Mr. WHITFIELD. Accurate, OK. Now, we have had a number of hearings on Keystone pipeline, and those people who are opposed to it I think I can characterize their description of oil sands production and so forth as being inherently dirty and inherently more risky than other types of oil. Would you agree with that characterization, Mr. McCaffrey?

Mr. MCCAFFREY. No, I wouldn't actually. When we look at the greenhouse gas footprints that we have relative to other U.S. imports, I think we have made great strides on it. It doesn't mean we can't continue to do better and that is what we are doing. We are focusing that on energy efficiency, and some of the things that we are working on right now in areas of technology are very exciting. But no, I wouldn't agree with that.

Mr. WHITFIELD. OK. Mr. Dyer in his testimony made this comment that in situ extraction had significantly more greenhouse gas intensity means it ostensibly produced more greenhouse gases than other methods of extraction and he said on average 2.5 times more intensive than mining as far as greenhouses go. Would you and Mr. Smith agree with that comment or not?

Mr. SMITH. Actually, Mr. Chairman, Dr. Isaacs would probably be the best person to——

Mr. WHITFIELD. Would you agree with that comment, Dr. Isaacs?

Mr. ISAACS. No, I wouldn't agree with that comment.

Mr. WHITFIELD. OK. Now, Mr. Dyer also said that there is a weak regulatory system in Canada relating to production of oil sands. Would you agree with that statement, Mr. Smith?

Mr. SMITH. No, I wouldn't, Chairman Whitfield, because Alberta recognizes that it has great and vast resource and it must be developed in an orderly manner and it must pay attention to environmental values and social values. It was the first province in Canada to have a Department of Environment. It was created solely for the purpose of managing these resources. We have a quasi-independent semi-judicial regulator that makes decisions on the development. It takes 3 ½ to 5 years to approve one SAGD process. A mining project has been in approval over 7 years. These panels are joint panels, Federal Fisheries and Oceans, Federal environmentalist departments, they will share in the panels. It is a very highly regulated and public process.

Mr. WHITFIELD. Thank you. My time is expired.

At this time I recognize Ms. Castor for 5 minutes.

Ms. CASTOR. Well, thank you, Mr. Chairman. Thank you all for your testimony.

I would like to keep on that line of questioning and understand that in Alberta you have an Energy Resources Conservation Board, Department of the Environment, Department of Sustainable Resource Development. They all maintain very robust rules for tailings management, land reclamation, water pollution, groundwater monitoring. So, because my time is limited, could you go down and just give me a yes or no answer. I think many of you have already stated this. Are those fundamental health safety and environmental regulations important? Yes or no?

Mr. ISAACS. Yes.

Mr. DAMMER. Yes.

Mr. NENNIGER. Yes.

Mr. MCCAFFREY. Yes.

Mr. SMITH. Without question.

Mr. DYER. Yes.

Ms. LABOUCAN-MASSIMO. Yes.

Ms. CASTOR. Well, see, the difference here in the great United States of America is that what the Republicans have tried to do is have this Keystone pipeline approved by passing a bill and giving short shrift to a lot of those health, safety, and environmental reviews, really giving them special treatment by passing a law and not adhering to things like the National Environmental Policy Act and others. And that is not fair. All of these entities should play by the rules.

Today, we have heard several witnesses testify about the ability of new technologies that attempt to minimize the impacts of tar sands oil development on strip mining, on water pollution, the lingering toxic chemicals in these large tailing ponds, the decades of dealing with the solid wastes that is left over and carbon pollution. And it is important that here in the United States we understand the impacts of the tar sands.

Mr. Dyer, based on your study of the tar sands industry in Canada, have environmental impacts of the tar sands been significantly mitigated through the deployment of new technology?

Mr. DYER. Well, I wouldn't take my word for it. I mean if you look at the Royal Society of Canada's report on the tar sands, which is the equivalent of your U.S. Academy of Sciences. They concluded that regulations haven't kept pace with oil sands development, so absolutely not. As was mentioned, there was an absolute boom in the oil sands and it left regulators unprepared to catch up with addressing cumulative environmental limits in the oil sands.

Ms. CASTOR. Thank you. And how about you, Ms. Laboucan-Massimo? Has technology fixed the environmental harms from tar sands production that are so devastating to the First Nations communities?

Ms. LABOUCAN-MASSIMO. In my opinion no, unfortunately, because what we are seeing are impacts of the land. We are seeing impacts to the air and to the water. And so we have seen exceedances happen from operations that impact the communities downstream and that are around the communities. We have seen cattle ranchers actually have they think connected to the emissions have their cattle miscarriage because of things like where they are feeling quite ill from the inability for them to capture fugitive emissions. So it is impacting people and I don't feel like it is doing its job.

Ms. CASTOR. And in addition to pollution of water and water quality issues, development of tar sands is a very water-intensive process. So it impacts water quantity. In fact, it takes as much as four barrels of water to produce just one barrel of bitumen from tar sands. And here in the United States it is reported that we have rich deposits of tar sands and oil shale in arid western States such as Utah and Colorado and Wyoming.

Ms. Laboucan-Massimo, can you speak to the impacts of tar sands development in Alberta on the local water resources? Go into a little greater detail on water quantity requirements and water quality.

Ms. LABOUCAN-MASSIMO. Well, the area where we are, the Peace-Athabasca Delta is a sixth of Canada's fresh water supply, so we are dependent on that water supply. It is very important to us so what we have seen is that industry has used this water as well so we are somewhat at competing needs for it. But the damage that we have seen happen to the downstream communities, you know, we are seeing unfortunately fish with tumors and such because of the contamination but we are also seeing lower levels of water in the area. So I have talked to elders that, you know, used to boat down from community to community and now they are hitting sandbars because there are decreased water levels in the areas.

And that is very concerning. For the scientific community where they are actually saying if there is decreased levels that will, you know, do a fish kill or a potential fish depopulation of the areas. So there is definitely downstream impacts as well as for communities around that region as well.

Ms. CASTOR. Thank you very much.

Mr. WHITFIELD. At this time, I recognize the gentleman from Illinois, Mr. Shimkus, for 5 minutes.

Mr. SHIMKUS. Thank you, Mr. Chairman. So many questions, so little time. First of all, I did meet with the chief elder of First Nation on my trip and although he was concerned about expansion, he did appreciate the hundreds of jobs, thousands of jobs available to tribal members in these operations. I want to put that on the table.

And again, this Keystone debate is really kind of goofy because we only spent 3 ½ years to study it. Ten thorough agencies all approved it. EPA said it was OK. So for us it just drives a lot of us crazy to hear these really fallacious false statements about the entire process.

Let me go briefly. I have got a couple pictures. Let us put the first one up. This is in response to my friend, Mr. Waxman. That is a recovered mine operation site. Now, I am from Southern Illinois. We had strip coalmining obviously in the first days, not very good environmental stewards. We recover coalmine operations now and that is a picture of before and after of a recovered, reclaimed surface mining operation.

Let us go to the next slide because it really dealt with my opening. We better start talking about the two different types of operations. For as much as the environmental left wants to keep beating us up, there are two different operations. And these three pictures show that. This is an in situ operation. Go the next picture. That is the footprint when it tails off. That is kind of the wells. Go to the next one. Of course the little pipeline and then the product. So I just need to put that on record.

Let me ask Dr. Isaacs. I have a quick question. You mentioned some technology company, communications company. What company was that?

Mr. ISAACS. Harris Corporation, headquartered in Florida.

Mr. SHIMKUS. Melbourne, Florida, I think, right?

Mr. ISAACS. Right.

Mr. SHIMKUS. So this is a big operation for them?

Mr. ISAACS. Yes.

Mr. SHIMKUS. Great. Mr. Dammer, I just want to thank you for talking about the 2005 energy bill. I was on the Conference Committee, great piece of legislation and I hope it helps us create additional operation in oil shale development.

Dr. Nenniger, when you are talking about your new operation, it sounds like you are putting a chemical solution down to recover the oil sands. Is that correct?

Mr. NENNIGER. Most likely, it is either condensing propane——

Mr. SHIMKUS. OK.

Mr. NENNIGER [continuing]. Which is what you burn in your barbecue or condensing butane.

Mr. SHIMKUS. And obviously, you have been following our debate on fracking. And you are doing a lot of research. Would you want to immediately disclose that list of operation to anyone who wants to use that or would it be proprietary information?

Mr. NENNIGER. No, it is absolutely open.

Mr. SHIMKUS. Good.

Mr. NENNIGER. We have technical papers on our Web site. We have 10, 15 patents so——

Mr. SHIMKUS. Great, thank you. I got short time. Let me go to Mr. McCaffrey.

Mr. McCaffrey, you have listened to a lot of some of the statements. I would like for you to address two issues—wheels-to-well carbon dioxide emission levels, and also I would you to address this water issue that was raised, especially in your expertise on in situ.

Mr. MCCAFFREY. Sure. In terms of wells-to-wheels analysis, we are focused on the energy intensity and we have been successful in continuing to reduce our greenhouse gas emissions throughout the last several years and we have a target of continuing to reduce those. It is all focused on improving our energy efficiency and using novel technologies like cogeneration and then seeing what we can do to substitute out the steam as we go along through infield wells and the use of natural gas, which is just methane in the reservoir. We just——

Mr. SHIMKUS. And you told me that that process is actually lower than the California carbon standards, is that correct?

Mr. MCCAFFREY. Absolutely. I think it is about 15 percent.

Mr. SHIMKUS. Great. Can you now move into the water usage issue?

Mr. MCCAFFREY. Sure. It is pretty much a closed-loop system where we recycle the water back—or we bring the water back when it is produced so it is condensed steam, drains down to the producer, we bring it back, we recycle it, and we use it over and over again.

Mr. SHIMKUS. So this number of the use of water in your operation is not true?

Mr. MCCAFFREY. No. No, we recycle 90 percent.

Mr. SHIMKUS. Great. Thank you.

Mr. Chairman, I will return back 19 seconds.

Mr. WHITFIELD. At this time, I would like to recognize the gentleman from California, Mr. Waxman, for 5 minutes.

Mr. WAXMAN. Thank you, Mr. Chairman.

Since last May, this committee has held four hearings on the Keystone XL tar sands pipeline and passed two separate bills to mandate approval of that pipeline, and yet the majority has never bothered to examine the impacts of tar sands production and transport on public health and the environment. In particular, there has been no effort to understand what a shift to tar sands fuel would mean for U.S. carbon pollution. So today's hearing is long overdue. And it appears that most of the witnesses here recognize that tar sands pose serious environmental threats that must be addressed. For example, every witness on this panel has provided testimony about efforts to reduce greenhouse gas emissions from tar sands productions. One of the witnesses invited by the majority, Dr. Nenniger, states that "the evidence of climate change is compelling

and terrifying." Another, Dr. Isaacs, states that "careful management of environmental issues, especially greenhouse gas emissions, is essential."

Mr. Dyer, are the tar sands operations really getting cleaner in terms of carbon pollution, and if not, why not?

Mr. DYER. In absolute terms, definitely not as we demonstrated here looking at the emissions doubling by 2020. And in terms of the intensity, the evidence suggests not as well. You know, this is government and industry data that says we have got a worsening trend in the past 6 years. Our data that demonstrates in situ development is more greenhouse gas intensive than mining is based on industry data and highlights in our report drilling deeper the in situ report card. So I think the data is quite clear that in situ, based on its requirements for steam, is more GHG-intensive than mining and that trend is currently outstripping any potential improvements.

Mr. WAXMAN. Mr. Dyer, are there technologies available that could substantially reduce greenhouse gas emissions for tar sands production?

Mr. DYER. Yes, there are but unfortunately they are expensive. And, you know, if you are making decisions about whether to deliver, you know, a responsible product that has low carbon emissions, adopting expensive carbon capture and storage voluntarily is not going to happen. So I think we are in a situation where we have been facing other great environmental challenges in North America. If we are serious about cleaning up some of the worst aspects of oil sands development, we should be willing to regulate them. And clearly the evidence is that Canada so far hasn't taken interest in regulating the oil sands.

Mr. WAXMAN. So there are no operating carbon capture and sequestration projects now. One is planned, as I understand it, but it is being heavily subsidized by the government. Absent such subsidies, the industry has no incentive to deploy technology, is that right?

Mr. DYER. That is correct. You know, there are dozens of projects in the regulatory queue currently in Alberta. And with the exception of the Shell Quest project, which will be built using taxpayers' dollars, none of those projects propose carbon capture and storage.

Mr. WAXMAN. Ms. Laboucan-Massimo, what is your view? Does the industry rhetoric about the sustainable development match up to the reality on the ground?

Ms. LABOUCAN-MASSIMO. In my opinion, no, it doesn't. What we are seeing is massive mines the size of entire cities. Pearl Mine will be bigger than Washington, D.C. What we are seeing is a number of in situ projects all over the region. I am from the Peace region. There is the Athabasca region. This region in total takes up the size of the State of Florida. We are talking about completely fragmenting or destroying a landscape the size of an entire State of the United States of America.

Mr. WAXMAN. The industry and Alberta government talk a good game but this is a classic example of greenwashing. The reality is that the carbon pollution from tar sands is growing very rapidly and the Alberta government is not willing to put the policies in place that would be necessary to change that. One claim we have

heard repeatedly about the Keystone XL tar sands pipeline is that if the U.S. doesn't take the tar sands crude, Canada will just send it to China.

Mr. Dyer, does Canada currently have the transport capacity in place to send the tar sands to China instead of the U.S.?

Mr. DYER. No. There is a small pipeline that currently goes to Vancouver but there is a major proposed pipeline the Enbridge Gateway project. That is facing even more opposition I would say in my estimation than the Keystone XL.

Mr. WAXMAN. Ms. Laboucan-Massimo, is this pipeline going to happen?

Ms. LABOUCAN-MASSIMO. No, in my opinion it will not happen. Over 100 First Nations are opposing this pipeline and over 80 percent of British Columbians themselves actually oppose the supertanker traffic that would need to be associated with the tar sands pipeline.

Mr. WAXMAN. Thank you. My time is expired. Thank you, Mr. Chairman.

Mr. WHITFIELD. At this time, I recognize the gentleman from West Virginia, Mr. McKinley, for 5 minutes.

Mr. MCKINLEY. Thank you, Mr. Chairman. Melina?

Ms. LABOUCAN-MASSIMO. Yes. Hi.

Mr. MCKINLEY. I am just curious if you could give me a little insight. Does your group or something similar—do you support drilling for oil in the Gulf?

Ms. LABOUCAN-MASSIMO. In the Gulf? Well——

Mr. MCKINLEY. Yes or no.

Ms. LABOUCAN-MASSIMO. No.

Mr. MCKINLEY. Do you support drilling in ANWR?

Ms. LABOUCAN-MASSIMO. ANWR which is where?

Mr. MCKINLEY. In Alaska.

Ms. LABOUCAN-MASSIMO. Oh, no.

Mr. MCKINLEY. Do you support the Keystone Pipeline, the conception of it?

Ms. LABOUCAN-MASSIMO. No, I don't.

Mr. MCKINLEY. Do you support surface mining for coal, like mountaintop mining, for example?

Ms. LABOUCAN-MASSIMO. Well, I have been to Kentucky and I have talked to people from there and it seems like the repercussions are similar to the tar sands so I would say in my opinion things have been sacrificed.

Mr. MCKINLEY. Do you support the fracking technique to get to the gas shale like in the Appalachian Mountains or in Texas or wherever shale gas is located? Is that something that your group would support?

Ms. LABOUCAN-MASSIMO. For fracking?

Mr. MCKINLEY. The fracking to get the gas out of the ground there.

Ms. LABOUCAN-MASSIMO. No.

Mr. MCKINLEY. So I am really curious where you are going with this. You know where I am going——

Ms. LABOUCAN-MASSIMO. Yes.

Mr. MCKINLEY [continuing]. And that is that we don't want oil, we don't want coal, we don't want gas, but yet we have a Nation

that depends on those. But you are saying that I want us to use—and that is fine. I am going to support the all-of-the-above, the renewables——

Ms. LABOUCAN-MASSIMO. OK.

Mr. MCKINLEY [continuing]. But I don't understand your point because you are trying to ban this. The technique that everyone has used up here has been very clever, the focus on the 20 percent that is not in situ. In situ, clearly you have seen the pictures how environmentally sensitive it is for that but everyone seems to be focused, even from the folks on the other side of the aisle have been focused so much on the negative of surface disruption. But coming from the construction industry 45 years, I would challenge someone if they have not been on a golf course to see a golf course constructed. Millions of cubic yards are disturbed to have a golf course but at the end of the day everyone enjoys it. Surface mining, I have seen them use then, after the surface mine, to use after the reclaim for shopping malls, schools, penal institutions. But you just always look at the worst side of it and that is during the construction. And again coming from a construction I don't think anyone ever likes a construction site during construction but when it is all done, when it is reclaimed, it is something positive. Why are you so focused on the negative?

Ms. LABOUCAN-MASSIMO. Well, what I am actually——

Mr. MCKINLEY. Because you are not willing to get oil, gas, or coal——

Ms. LABOUCAN-MASSIMO. Well, it is actually asking for more of a transition away from oil and gas and the associated greenhouse gas emissions that are causing issues worldwide. We need to transition away from that and actually put our investments in renewable energy systems so we can actually have healthier communities.

Mr. MCKINLEY. OK, Mr. McCaffrey, if I could go to you just for a minute.

Back in May of last year, we had some testimony here in a hearing and there were issues. I would just like your comments that were given to us by—it said on a lifecycle basis, tar sands may emit almost 40 percent more carbon pollution than conventional fuel. Would you agree with that?

Mr. MCCAFFREY. No, I wouldn't.

Mr. MCKINLEY. OK. There was another testimony on the same day that—we have talked about pipeline safety because a lot of the opponents are trying to indicate that it is dangerous what we are doing. There was testimony said including the bitumen high pressure, including internal corrosion, abrasion, and stress corrosion cracks only weaken pipelines over safety. And then it went on to say that Alberta's scorched earth tar sands operations are the most destructive sources of oil on the planet. Would you agree with those statements?

Mr. MCCAFFREY. Absolutely not.

Mr. MCKINLEY. Back to Mr. Smith. Can you touch on just a little bit about the revenue source, what impact your revenue source has been on the Nation with Canada, what you have been able to facilitate in Alberta? Has that had a positive impact? Has that provided revenue to the country to get out of its own——

Mr. SMITH. Well, there are significant studies done by major and reputable economic groups across Canada and the United States that talks about an oil sands barrel delivers more economic value to the United States than any other barrel that you use import or derived in the world today. Member Shimkus talked about Caterpillar and Michelin, Chicago Iron, the number of companies that are involved in the oil sands——

Mr. MCKINLEY. I know my time is essentially expired, but if we in America couldn't mine coal or can't burn coal and we couldn't use oil or gas, what do you think our role is as leaders? How long do we——

Mr. SMITH. North America's economic recovery has always been based on reasonable and low-priced energy costs and will continue to be that way.

Mr. MCKINLEY. Thank you very much.

Mr. WHITFIELD. The gentleman's time has expired.

At this time, I recognize the gentleman from Texas, Mr. Green, for 5 minutes.

Mr. GREEN. Thank you, Mr. Chairman. And let me for the record correct—there were some statements made earlier by our ranking member that talked about the Keystone pipeline was trying to get ahead of what is normally required for pipelines in our country. That is just not true. The Keystone pipeline has had, you know, one environmental impact statement with two supplemental and it was still approved by the EPA. So that is even more than the typical pipeline from Texas to Cushing, Oklahoma, that is the southern leg of it that the President supports. So there has been no exceptions. You know, when you have study for 2 ½ years on a pipeline, you obviously are going to get a lot of reviews so there have been at least one full environmental impact and two supplementals and approval by the EPA of the Keystone pipeline. And that is subject to even more reviews than our typical pipeline safety law, even the ones that we just passed that is now law. So the Keystone pipeline has been reviewed. Now, I don't know wherever the people get their information.

Let me ask some questions, though, of Mr. McCaffrey. A number of what happens at the oil sands is you are using cogeneration to natural gas to use to provide steam for the process in the in situ. How many of the current oil sands sites are using cogeneration?

Mr. MCCAFFREY. I don't know the exact number but I would guess that there are three or four that are doing it, but a lot more are starting to flag it as a very viable way to go.

Mr. GREEN. And you mention in your testimony the technology developed largely along reducing the steam-to-oil ratio in the in situ operations. Is that also a process that is being more expanded?

Mr. MCCAFFREY. Yes. The industry is very, very focused on reducing the steam-to-oil ratio and seeing great successes. And every quarter that goes by you see improvements. There are other companies besides ourselves that are just putting great effort in as well.

Mr. GREEN. Is that natural gas produced somewhere close to the sites?

Mr. MCCAFFREY. Typically, it is in Alberta. It is quite often very close to the sites.

Mr. GREEN. OK. So we don't have to worry about pipelines to bring that natural gas to your well sites?

Mr. MCCAFFREY. No, there is significant infrastructure in Alberta already.

Mr. GREEN. I know the issue is fresh water, even in Alberta but, you know, in Texas obviously hydrofracking has been very successful but it takes a tremendous amount of water. What happens to the water? Is most of it recycled?

Mr. MCCAFFREY. Yes, we recycle about 90 percent of it. And the water we originally use is non-potable so it is saltier water and it is from deep aquifers. We do not use any surface water, no rivers, no lakes in our operations.

Mr. GREEN. And what happens to that 10 percent——

Mr. MCCAFFREY. And I am referring to most of the operations in the south. Towards the north where it outcrops, they do need to use the Athabasca River.

Mr. GREEN. OK. Also, Mr. McCaffrey, in 2010 Big K Energy Corp contribution and Greenhouse Power offset 238,000 tons of GHG production. Was that based on the In Situ Oil Sands Alliance or where did that number come from?

Mr. MCCAFFREY. That comes from our own operations and we are planning to put in more cogeneration because of the benefits we see on our future phases right now.

Mr. GREEN. OK. Mr. Smith, Ms. Massimo writes in her testimony the government of Alberta actually allows the industry to self-report in this system where there is no independent third party regulating. Is that true?

Mr. SMITH. The Energy Resources Conservation Board is an independent regulator. In fact, you can go to a Web site today with the Department of Environment and see active air quality life on a real-time basis. The maximum flow from the Athabasca River that the oil sands companies can extract in its development does not exceed 4 percent. So there is extensive water conservation, water management, and it is independently regulated at this point through rules and permits.

Mr. GREEN. I was wondering because our gas wells that we hydrofrack, obviously OSHA has access to those sites and EPA has those on the U.S. side, so I assume Alberta has some of the same government oversight regulations. You can send an inspector out and verify whatever self-reporting is being done?

Mr. SMITH. Absolutely.

Mr. GREEN. To verify that number.

Mr. Dyer, in your testimony, based on approved water licenses and current proposed projects where they draw 15 percent of the Athabasca River flow during the lowest period introducing fish habitat, if the producers are going to move to in situ production in order to reach the resource, if it is doing so, they are not going to use fresh water instead of using recycled water is the testimony. In your statement, what was your basis for, "based on approved water license, the 15 percent of the river's water flow?"

Mr. DYER. A basic problem with your statement there, companies are not moving to in situ oil sands development. Oil sands mining is expanding and it is going to trickle. It is just in situ development is actually expanding at a fast rate. So we are still going to see

three times the impact on the Athabasca River from mines. It is just because more in situ——

Mr. GREEN. OK. Well, you are talking about the strip mining?

Mr. DYER. Yes, that is correct.

Mr. GREEN. OK, but——

Mr. WHITFIELD. Gentleman——

Mr. GREEN [continuing]. Mr. Chairman, I understand that 80 percent of the production is going to come from in situ and only 20 percent from the strip mining is my understanding.

Mr. DYER. Yes, that is correct——

Mr. GREEN. OK.

Mr. DYER [continuing]. But we have only produced 3 percent of the bitumen so far so there will be lots more cumulative effects for both mines——

Mr. WHITFIELD. At this time I will recognize the gentleman from California, Mr. Bilbray, for 5 minutes.

Mr. BILBRAY. Thank you, Mr. Chairman.

First of all, I guess I need to clarify some items that the representative from Greenpeace was able to bring up. Your concerns about oil or natural gas, how about does Greenpeace support corn ethanol and the use of corn ethanol in the mandates?

Ms. LABOUCAN-MASSIMO. I can't comment on that right now.

Mr. BILBRAY. OK. How about the expanded use of algae production for the——

Ms. LABOUCAN-MASSIMO. That is also not my study of expertise.

Mr. BILBRAY. No alternative fuels. OK.

Mr. Smith, I have some real questions. As somebody who has been involved in the environmental movement in one way or the other since 1970, I am just trying to think of a country anywhere in the Western Hemisphere that is at least historically been perceived as environmentally sensitive. I cannot think of a country that at least the public perceives as environmentally sensitive than Canada. In fact, I remember operation Canadian Bacon was the way we were going to attack you guys was we were going to throw trash into your parks.

Mr. SMITH. I think, Mr. Bilbray, we also said we walk amongst you undetected.

Mr. BILBRAY. And we worry about that. Has Canada made such a huge shift from its history of being the environmental leader of the Western Hemisphere, leader in everything from, you know, renewable resources to greenhouse gas control? How can I sit here and believe that Canada has totally abandoned its standard of environmental protection that has historically been there and taking a walk on this issue? Has Canada been taken over by some evil foreign force and forced you guys to have to trash the environment?

Mr. SMITH. Well, Honorable Member, Canada and resource-producing provinces of which there are now six have responsible permitting, they pay attention to changing environmental conditions, to they pay attention to that triple bottom line of environment, social values, and corporate profit. We have been able to weather a serious, serious recession because we do produce a great abundance of natural resources and natural minerals and products. We continue to clean up oceans and fisheries and ponds—the Sydney Tar Ponds, for example. We have environmental records of excellence.

I think that as we grow, we are going to continue to get better and better about defining surface reclamation.

One of the issues is that we are transparent. We are not afraid to put our record out front, have the discussion, have the debate, and where we can find need for change, we implement change. And it not that anything has remained static, neither the development of the resource, nor the regulations that surround it. So it is an ongoing process. There is dynamic tension. We still import in excess of 700,000 barrels a year on our east coast a day. And I believe that we can replace that with oil sands crude. Once we do that, that oil sands crude will then go into eastern markets in Canada and we will also find a gateway to foreign shipping. In fact—and I thank the U.S., for Congress to give that permission to build that pipeline from Cushing to the Texas Gulf Coast because that is going to increase the abilities for your refineries to use Canadian crude and not crude from hostile jurisdictions that really want to take the money they gain from selling oil to you and use it against your interests.

Mr. BILBRAY. Now, I remember we were negotiating with Mexico about an oil line back in the '70s and the '80s and there were those that stood in the way. That oil now, instead of being transported through a pipeline, is being transported through trucks and tankers. And actually, a lot of those tankers are going into Houston as we speak. My question though is you have pointed out—who is Canada's number one trading partner in the world?

Mr. SMITH. You are.

Mr. BILBRAY. Who is America's number one trading partner in the world?

Mr. SMITH. We are.

Mr. BILBRAY. So we are sort of tied together here from that aspect of it. My question though is it appears to me when I look at the Keystone pipeline that the problem with the administration is not the EPA, is not the water quality control people. There is no controversy on that side. It comes down to a 5-foot artificial barrier called the international border between Canada and the United States and that the issue is not issuing the permit for you to bring a pipe up to your side of the border and for us to bring a pipe up to our side of the border. That is what is being held up here. So my question is, is it true to say that this issue really is not about the environmental impact in the United States, not the environmental impact on our water or resources in the United States, but more an issue about the United States trying to impose a regulation onto Canada and hold Canada to change its environmental policies and that the State Department—not the EPA—will not allow you to connect to a pipeline on our side unless you change something on your side of the border?

Mr. SMITH. We are continuing to provide a safe, secure, reliable, geopolitical, sensible stream of product to a nation that needs the product desperately.

Mr. BILBRAY. Thank you.

Mr. WHITFIELD. The gentleman's time is expired.

At this time, I recognize the gentleman from Texas, Mr. Olson, for 5 minutes.

Mr. OLSON. I thank the chair and welcome the witnesses. I am sorry you are here today because of election-year politics. It was clear that something changed this past fall with the President's handling of the Keystone XL pipeline. The Department of State wanted the pipeline. The labor unions wanted the pipeline. The environmental activists didn't want the pipeline. The President ruled and deferred the decision because of the elections coming up this November. But one thing we have learned since that time is the Keystone XL pipeline is safe. Why else would the administration approve the first portion of it being built from my home State of Texas up to Cushing, Oklahoma, unless it was designed to be safe? Why would they do that? And the President still has an opportunity to do what is right for the economy, approve the full Keystone XL pipeline now. Unfortunately, he is still being misled by the environmental activists and the Hollywood elites.

The Keystone pipeline, not the XL pipeline, but the Keystone pipeline already brings Canadian oil sands crude across the border, across that aquifer in Nebraska and to Wood River in Patoka, Illinois. The exact same oil is flowing through the pipeline right now across the border to the United States. The protesters that surrounded the White House are waging a new war against Canada's oil sands. It has happened already. And as we have heard from the witnesses today, Canada's oil sands present an incredible opportunity for American energy security. Coupled with White House Press Secretary Carney's admissions that we have "world-class, state-of-the-art refineries on the Gulf Coast," we can ensure Americans have access to affordable energy for our children and our grandchildren.

My first question is for you, Mr. Smith. Some claim that the Keystone XL pipeline is designed to ship oil from Canada through the United States to our "world-class, state-of-the-art refineries on the Gulf Coast" and out to Asia. But if you simply look at a globe you would see that Canada's west coast is much closer to Shanghai than it is to Houston. And on the same globe you might find a pipeline connecting Alberta to the Gulf of Mexico is a lot longer than a pipeline connecting Alberta to the Pacific. Why is the Keystone XL pipeline being proposed?

Mr. SMITH. Well, Honorable Member, I was here when Keystone I was approved and had its presidential permit. Oil sands crude has been reaching markets in the United States since the 1980s. It continues to grow. Production continues to grow. It creates opportunities, it creates jobs on both sides of that border, and I believe that ultimately we can have a North American answer to energy security and independence with reasonably priced energy prices that will stimulate economic recovery in both countries.

Mr. OLSON. How does building a pipeline through the U.S. an efficient means of accessing Asian markets?

Mr. SMITH. Each time you touch a barrel of oil, it becomes worth more money and thereby more expensive. So if there is a market closer, that is where the shippers go. That is where the producers would like to provide that produce. So it is a reach to think that you would move into a big ship that has a proclivity for a spill and it is also very expensive. So I would be very surprised, particularly in light of refinery closures on the northeastern side of the United

States that oil reaching the Texas refinery complex would go anywhere else but the United States of America.

Mr. OLSON. Yes, sir. Thanks for that.

One more question for you, Mr. Dammer. We have heard from Mr. Smith on how Alberta achieved basically energy independence and the positive effects that oil sands have had on their economy. And I saw a very similar thing in my home State of Texas about 3 weeks ago with the Eagle Ford Shale Play. A little different source of energy, it is true oil and true natural gas, but the exact same thing is happening in many cities across Southeast Texas. In very underprivileged cities, underprivileged counties, one example in Dimmit County the sales tax revenue has gone up 300 percent, the property tax revenue has gone up 400 percent making a real difference in the quality of lives of those people in my home State.

And I mean if the United States had the same attitude toward oil shale, do we think we could have similar results across the country, not just what you experienced in Alberta and what we are experiencing in Texas?

Mr. DAMMER. Yes. Absolutely. As I said in my testimony, there are over 30 companies working on oil shale R&D here in the United States, and many of them have shown a lot of promise. Shell is working in situ; Chevron, Exxon, some of the larger companies are spending billions of dollars in trying to release the huge reserves that are locked in the Permian Basin. I think the problem we have here in the United States is we have no national program similar to the one that they put together in Alberta that directs the types of research and development toward these resources. We throw programmatic EIS at it, we do oil shale regs and then we revoke the oil shale regs and then we do another programmatic EIS. And that is why I brought up the fact that we have on the books a law, Section 369(i), that calls for a national program to develop these resources. And I think if we followed the presets of that law, we would safely and comprehensively start to develop those resources.

The reason why Shell is having so many problems in Colorado is they have no assurance that they will ever get out on the Federal land.

Mr. OLSON. I am over my time, Mr. Chairman, but I want to thank our witnesses from Canada. As a former military veteran, thank you for standing beside us in the War Against Terror. I know over 200 of your brave men have given their lives beside us in Afghanistan. I really appreciate that. We will stand beside you. I yield back.

Mr. WHITFIELD. At this time I recognize the gentleman from New York, Mr. Engel, for 5 minutes.

Mr. ENGEL. Thank you very much, Mr. Chairman.

I really have an open mind about this. I believe very strongly that the United States can never be totally free in our foreign policy and such similar matters unless we wean ourselves off of oil that we get from unfriendly nations, and I think that Canada certainly is the friendliest nation. So I think that there is potential there, but I am concerned about the environmental difficulties. So I have just a couple of questions.

Canadian tar sands obviously aren't regular oil. They are highly corrosive and very carbon-intensive. And obviously as lawmakers we have to evaluate the immediate health and environmental consequences of tar sands production, weigh our obligations to leave full functioning ecosystems for future generations and consider our responsibility in terms of adding greenhouse gas emissions to our planet. I take those responsibilities very seriously, and obviously, everything is a balance.

In January 2012, Canada became the first nation to withdraw from the Kyoto Protocol. Now, we have never joined it so in a way people that live in glass houses shouldn't throw stones. But when Canada withdraws from it, I wonder why. It makes me suspicious. Every oil sands developer claims they can clean up the bitumen production with better technology, but from what I have seen—and please correct me if I am wrong—this technology doesn't yet exist, and the hard truth is from what I can see, the energy industry hasn't been really investing much in innovation.

And I say this because according to Forbes, big energy companies devote barely 0.3 percent of their sales to research and development and many have ended their R&D programs. And if the technology worked really well, it would use less energy and steam over time to produce more bitumen. But exactly the opposite has happened. In the late 1980s, 2.38 barrels of steam was considered to produce a barrel of in situ bitumen and in 2010 the steam industry average increased to 3.3 barrels. So that is a 50 percent decline in efficiency over a 20-year period. So I don't know. You look at the energy companies, they profit from commodity price increases, not ingenuity. So it is almost a disincentive for them to come up with these things. So I am concerned about development without proper fiscal, political, and environmental safeguards, and I would be happy if anyone would want to comment on what I have just said, either people from the industry or others as well. Mr. McCaffrey?

Mr. MCCAFFREY. Sure, I would be happy to.

Just speaking from our own company's perspective, our numbers are we design our plant for steam-oil ration of 2.8, which are the numbers you are referring to. We are currently at a 2.4. We are targeting to get down to 2. We have got technology that we think can be implemented now and that we are working on getting implemented to drive us in that direction. And some of the other companies in the area are also moving in that direction and they are being successful at it. So the technology that may have changed over time would have been cyclic steam technology is now steam-assisted gravity drainage, and that is a far more efficient process. And directionally, we are seeing good gains in that area.

Mr. ENGEL. Mr. Dyer, didn't you in your testimony say that the tar sands are not getting cleaner and that technology is expensive and therefore that is the reason? Would you disagree with what——

Mr. DYER. Yes, that is correct. There have been improvements since 1990, as I mentioned, but in the past 6 years we are starting to see declining intensity. I think, you know, if the industry is confident that improvements will still happen and we have innovation there, I think you would see them embracing the ability to dem-

onstrate that through regulation and through low carbon fuel standards that would enable low carbon fuels to compete.

Mr. ENGEL. Let me ask you this question. And anyone who wants to answer it may. What happens if these pipelines are not built? Will Canada continue to produce tar sands oil for the U.S. and Canada? Will it run out of customers before it runs out of product? What happens if this is not built? Mr. Smith?

Mr. SMITH. Thank you, Honorable Member. Yes, we will continue to increase production in this process. They will find alternate markets. Oil is a fungible commodity, which means it can be exchanged around the world on a computer transaction or a moment's notice, and I believe that more and more of that will happen. They will find outlets for direct shipment either to the east coast or through—there is a pipeline, the Kinder Morgan Trans Mountain pipeline that was built by Becton back in the '50s. That line has a corridor and can be doubled in size without great difficulty. That takes care of 400,000 barrels. 500,000 barrels can go to eastern Canada to replace foreign import that we import. So we can find a market for a million plus barrels.

It is also important to mention that we have received tens of billions of dollars of investment from sovereign-owned companies from around the world, including China, Korea, and the Middle East. So in fact they are realizing that we have a fungible commodity.

I just also want to talk to you briefly—and Dr. Isaacs may want to supplement. We have a fund in Alberta that has contributed over $230 million simply in the last 3 or 4 years to better improving technologies for greenhouse gas reduction, energy efficiencies, and better practices in the oil sands. Our surface disturbance in the oil sands today is about the size of the city of Tampa. The size of the oil sands deposit is about the size of the State of Florida and we will be reclaiming that. And I am not sure that Tampa will ever get reclaimed. So we have a mine plan that goes forward every time and they have to provide reclamation programs to get things back equal to or better than—which is the watch word of the Department of Environment.

Mr. ENGEL. Thank you.

Mr. WHITFIELD. The gentleman's time is expired.

At this time, I recognize the gentleman from Virginia, Mr. Griffith, for 5 minutes.

Mr. GRIFFITH. Thank you, Mr. Chairman.

I guess I am somewhat curious. If the oil sands are going to be used anyway even if we don't build the pipeline, then I guess I am kind of curious as to why all the opposition to the pipeline, and I am wondering if any of you all can—start with Dr. Isaacs. Can you give me some explanation as to why, if the oil sands are still going to be used, why someone would oppose this pipeline coming into the United States? From a U.S. perspective—I know you all are mostly Canadians but can you all understand that?

Mr. ISAACS. No, I can't understand that.

Mr. GRIFFITH. Can you understand that, Mr. Dammer?

Mr. DAMMER. No, I don't understand that at all.

Mr. GRIFFITH. Doctor?

Mr. NENNIGER. I am sensitive to some of the issues but I am not sure that is the right way if, you know, you are concerned about carbon emissions that really is effective.

Mr. GRIFFITH. All right. Mr. McCaffrey?

Mr. MCCAFFREY. No, I don't understand it.

Mr. GRIFFITH. Mr. Smith?

Mr. SMITH. We are already shipping 1.7 million barrels south and also if I were receiving oil, I would want it in the safest way possible in the newest infrastructure possible.

Mr. GRIFFITH. Let me touch on that in a minute, Mr. Smith. I have heard previous testimony about shipping it the way that we are shipping it now in the United States, we actually have a bigger carbon footprint than if we build the pipeline. Is that accurate?

Mr. SMITH. Well, if you bring it in by tanker load, when you go quantity to quantity, the increased amount of emissions from tanker traffic than by pipeline.

Mr. GRIFFITH. All right. And you talked about safety as well. Is there more likelihood of accidents if you are doing the tankers?

Mr. SMITH. Well, it is your safety program, Honorable Member, and it will be a pipeline built by Americans, supervised by Americans and made safe by Americans. That includes union and nonunion labor.

Mr. GRIFFITH. All right. I appreciate that.

Let me ask you as well, Mr. Smith. You know, we always hear that the U.S. possesses only 2 percent of the world's proven oil reserves. Now, we know that that is because proven reserve estimates only account for oil fields that are currently being produced. However, not long ago Canada had a similar proven reserve figure to ours. Did your government accept that Canada's proven reserves in 1994 should mean that there should be no new oil exploration?

Mr. SMITH. No, it did not. What it meant was that we had to find a way to publicly quantify and qualify these reserves. The oil sands reserves are based on public record of 56,000 wells and 6,000 cores. Drilling records and core samples remain intact today and they can be viewed by anybody from this community. And I believe that much of the criticism that we get from the oil sands is our own fault because we are too transparent, we might be too apologetic, we might be too Canadian.

Mr. GRIFFITH. Well, I am not sure I would go there, especially as an American. I don't want to accuse you of being too Canadian. But, you know, does this not say to us that the United States can learn that if we go out there and we look for new ways to discover new ways to use what we have in our country that we can in fact discover new ways to use what we have and come up with a greater percent than the 2 percent that we always hear bandied about in the press when the President tries to give us math lessons?

Mr. SMITH. One of the great things that Canada and the U.S. share is technology development, innovation, and germination and pollination between companies. And whether it is horizontal drilling, measurement while drilling, hydraulic fracking, production of gas from shales, production of liquids from shales, production of oil from shales, these technologies are shared across the border. The 49th Parallel doesn't mean much when you are moving technology

throughout. And I think that the Bakken Field in North Dakota is a very good example of that.

Mr. GRIFFITH. So you would generally agree with me that we probably have greater than 2 percent if only we would use our resources, is that correct?

Mr. SMITH. Yes.

Mr. GRIFFITH. Yes. Dr. Isaacs, your testimony states that only the U.S. and Canada are the only developed countries that can dramatically increase oil production. There are other parts of the world that are producing large amounts of oil and will experience some growth, but are any of the other countries in the world that are expanding their growth, are they committed to producing oil with comparable environmental sensitivities to that of the United States and Canada?

Mr. ISAACS. I don't believe they are.

Mr. GRIFFITH. And so would I be correct in believing that by not allowing the United States and Canada to expand our use of our natural resources, we may in fact be creating a greater problem worldwide with pollution than if we are allowed to use with our sensitivities to the environment are allowed to use our natural resources? Is that true?

Mr. ISAACS. I think it is very possible, yes.

Mr. GRIFFITH. I appreciate it and I yield back my time, Mr. Chairman.

Mr. WHITFIELD. At this time I recognize the gentleman from Louisiana, Mr. Scalise, for 5 minutes.

Mr. SCALISE. Thank you, Mr. Chairman, and thanks for having this hearing on the American Energy Initiative. I know this has been a series of hearings that we have had on this in addition to the legislation that you have brought forward through this committee to help our country become more energy independent. And at the end of the day when we look at the skyrocketing price of gasoline and projects are it is only going to go higher, I think most people recognize that supply does have a factor in price. You can't ignore that basic fact of economics. And we have done a lot of things in this committee not only to increase the supply in America, to open up more areas that are currently closed, but also to create what would be hundreds of thousands of new American jobs that would go along with it. And of course here with the Keystone XL pipeline proposal, I know we have seen projections that on the low end there would be 20,000 new jobs created, over $5 billion of private investment that would be brought in, not this Federal stimulus program of spending money we don't have but actual private investment to build this pipeline.

Mr. Smith, if you can address the jobs issue because there have been some that have criticized that not enough jobs have been created or that the 20,000 number is not accurate—I have heard it is even higher but there are some suggesting it is lower as if only a few thousands new jobs is a bad thing, they oppose that. If you can address the jobs issue on what the estimates are that Keystone would create in America, the United States.

Mr. SMITH. Well, what we do know is that economic recovery is always based on reasonable energy prices or energy prices that are more competitive than the balance of world markets. To construct

that pipeline, it is my understanding that it is a shovel-ready project, requires no taxpayers' dollars, and the number of direct and indirect jobs have been wildly debated. And I believe that the number of 20,000 immediate jobs in a country with 8.3 percent unemployment would be significant.

Mr. SCALISE. 20,000 immediate jobs. And in the long-term, what estimates do you have there?

Mr. SMITH. I think the long-term is probably more difficult to calculate because as you move into economic recovery with reasonable and secure energy prices, you do ramp up over all economic activity. So I have heard in the range of 50,000 indirect.

Mr. SCALISE. Great. And, you know, of course some, including the President are suggesting they need more time for environmental concerns and all of that. And of course one of the facts that they leave out is that even if the President were to approve Keystone, which, you know, has been on his desk for over 3 years and there have been environmental studies that have suggested it would be a positive thing to do, each State would have to permit it, even Nebraska where, you know, there has been a lot of attention given to Nebraska's route. The State of Nebraska would still have to issue a permit before the pipeline could be built even if the President said yes, which of course the President has not. Is that correct?

Mr. SMITH. That is my understanding.

Mr. SCALISE. Yes. And so, you know, as the President tries to say he is for an all-of-the-above energy strategy, you are not for all-of-the-above if you say no to Keystone and so many other things that we have seen him say no to.

There is one final question as a follow-up to my colleague from Virginia asked on this 2 percent—because I know the President said this; others have suggested that in America there is this finite 2 percent amount of all the world's known reserves. And of course in Canada they were using similar numbers even going back to 1994 numbers before of course some of the new technologies came out. And as many know, you know, that known number of reserves only counts where there is actual production. If you are shutting an area off to exploration, there could be a vast amount of reserves that are there; we just don't know about them because the Federal Government won't let them go there. How did you all address that in Canada when you had a similar kind of smaller number of known reserves before the new technologies were allowed to advance?

Mr. SMITH. Well, Honorable Member, that is an important distinction. The resources are managed by each individual province/state if you will. They have an independent jurisdiction and the Federal Government is basically forbidden by the constitution to interfere in the orderly development of those resources or the trade and commerce of the provinces with those resources. So my direct experience was transparent records, environmental surveillance, a keen and strict regulatory process, and an ability to communicate that throughout the jurisdiction. Even with this great amount of debate, continually polls across Canada support the orderly development of the oil sands.

Mr. SCALISE. Well, thanks. And then the final question, Mr. McCaffrey, if you look at Canada's oil field discovery, it increased

their proven reserves by an order of magnitude of multiple times over. Can you kind of give your commentary on how this was accomplished?

Mr. MCCAFFREY. I think it is through the advancement of technology. We continue to see incredible improvements in terms of the recovery factors and being able to demonstrate those recovery factors. And I think it really echoes the point of the sheer size of that resource that is commercially recoverable. And we have a large number of customers from the U.S. right now on the Gulf Coast that are very interested in connecting with the supply. So as this supply has come on, as it continues to improve in efficiencies, there is a vast majority of the refineries on the Gulf Coast that have come up on a regular basis saying we need the crude; we have got to get the crude. And that is the only thing is the pipeline that is preventing the customer from getting the supply it needs.

Mr. SCALISE. Well, thank you all for coming and thanks, Mr. Chairman. I yield back the balance of my time.

Mr. WHITFIELD. Thank you, Mr. Scalise. And I want to thank those members of the panel for being here today. We appreciate your testimony very much. And I do think that this hearing brought to a clear focus the different policies in Canada and in the U.S., and because of Canada's policies they have gone from a net importer to a net exporter. And we recognize that there are many groups that sincerely do want to stop the exploration, production, and use of fossil fuels, but the reality is for our transportation needs we don't have any alternative right now. So this hearing has really been helpful and we appreciate your expert testimony.

And with that I will adjourn this hearing and we will keep the record open for 10 days for any materials that need to be admitted. Thank you.

[Whereupon, at 12:12 p.m., the subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

**Opening Statement of the Honorable Fred Upton**
**Subcommittee on Energy and Power**
**Hearing on "The American Energy Initiative: A Focus on the Future of Energy Technology with an Emphasis on Canadian Oil Sands"**
**March 20, 2012**

As we continue our American Energy Initiative hearing, today's focus is on one of the most significant energy success stories in recent decades – the emergence of Alberta's oil sands as a major source of North American supply. There are many lessons to be learned from the development of these oil sands that should be applied to American energy policy.

The story of Canada's oil sands is a story of energy innovation. It's a story of scientists and engineers taking a form of unconventional oil once thought too impractical to develop and turning it into a source of 1.7 million barrels per day, with the potential for 3 million barrels per day by the end of the decade.

President Obama talks quite a lot about energy innovation, and has spent billions of taxpayer dollars on all sorts of energy projects that have yet to pan out. There is much to criticize about the President's approach, including his "government knows best" philosophy of Washington picking winners and losers.

But the President's energy policy also suffers from having too narrow a view of energy innovation. He is only interested in developing completely new sources of energy, like advanced biofuels. But innovation is not just about new sources of energy. It is also about breakthroughs that allow us to get more out of existing sources of energy. That is what we have seen with unconventional oil in Alberta and what we could also see in America.

It is worth noting that predictions of declining natural gas production have given way to technological advances unlocking vast domestic supplies. I believe we could accomplish the same thing with oil. But it will only happen if our government allows it to happen, just as Canada's government has.

In other words, Canadian oil sands is not just a story of technological success, it is also a story of policy success. It's a story of a government working with the energy companies that made oil sands production a reality. In contrast, we routinely see our federal agencies treating energy producers as adversaries to be defeated. And the current administration has been especially hostile to conventional and unconventional oil projects here in America.

The people of Canada and America both strongly support responsible development of domestic energy sources. They both understand the benefits of expanding North American supplies and the need to do so with reasonable environmental safeguards. Of course, I might add that both nations also have a vocal minority of anti-energy activists. But the Canadian government does a much better job responding to all voices. Development of Alberta's oil sands is an example of a balanced approach to energy production. That balance is missing in the U.S.

Canada's oil sands success has two components – energy below the ground, and sensible policy above it. America has the first, and now we need to embrace the second.

###

CAPP
CANADIAN ASSOCIATION
OF PETROLEUM PRODUCERS

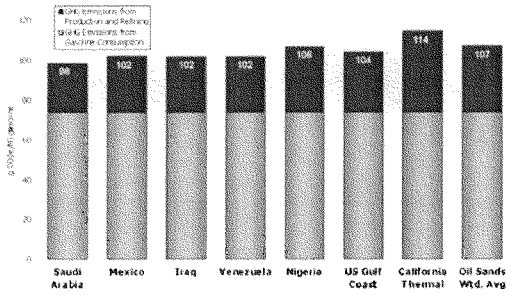
**Re: Hearing on "The American Energy Initiative- A Focus on Future of Energy Technology with an Emphasis on Canadian Oil Sands"**

The Canadian Association of Petroleum Producers (CAPP) would like to take the opportunity to provide a statement to the House Subcommittee on Energy and Power. CAPP is the industry association representing the Canadian upstream oil and gas sector. Our member companies are responsible for over 90% of Canada's crude oil and natural gas production. This statement provides further information on Canadian oil sands for the Hearing on "The American Energy Initiative- A Focus on Future of Energy Technology with an Emphasis on Canadian Oil Sands" held on March 20, 2012 by the House Subcommittee on Energy and Power.

**Greenhouse Gas Emissions**

According to IHS CERA report, "*Oil Sands, Greenhouse Gases, and US Oil Supply: Getting the Numbers Right*" (September 2010), oil sands crude has similar greenhouse gas (GHG) emissions to other heavy oils and is 6% more intensive than the U.S. crude supply average on a wells-to-wheels basis. Also, on a wells-to-wheels basis, in situ operations are on average 5 percent higher in GHG emissions than mining operations. The following chart shows the weighted average of oil sands GHG emissions compared to other crude sources around the world.

**Fig. 1. Full cycle GHG Emissions**




*Source: Jacobs Consultancy, Life Cycle Assessment Comparison for North America and Imported Crudes, June 2009*

Furthermore, industry continues to develop and incorporate energy reducing technologies and is committed to demonstrating the commercial and technical viability of Carbon

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Capture and Storage (CCS) in Canada. It makes sense to partner with government and third parties as it involves capital-intensive research and its success can be applied to sectors outside oil and gas.

CCS is well understood from a technical perspective, but widespread implementation is limited by challenging economics and a lack of infrastructure. There are currently several CCS projects operating in Western Canada, including Cenovus Energy's Weyburn Project and PennWest Energy's Joffre Project.

As the required infrastructure is developed, CCS has the potential to reduce GHG emissions from the oil sands, particularly at oil sands upgraders. Capture and storage of readily available concentrated CO2 streams such as those associated with hydrogen production facilities at upgraders may be feasible in the near to mid-term with investment in pipeline and injection infrastructure. The Alberta Government has awarded funding from the $2 billion CCS investment fund to Shell's Quest Project, which is planned to capture more than one million tonnes of CO2 per year from Shell's Scotford Upgrader, located near Fort Saskatchewan, Alberta. This is equivalent to taking 175,000 cars off the road.

**Water Quality and Monitoring**

In regards to oil sands production on water quality, the Royal Society of Canada (similar to the U.S. National Academy of Science) in 2010 established an Expert Panel of independent Canadian Scientists to review and assess evidence relating to several perceived environmental impacts of the oil sands on regional water supply. While also calling for enhancements to existing water monitoring, the results noted that "evidence on water quality impacts on the Athabasca River system suggest that oil sands development activities are not a current threat to aquatic ecosystem viability".

Reliable, long-term water monitoring based on sound science is supported by the industry. Valuable data has been gathered by existing monitoring systems and the recently announced joint federal/provincial government led enhanced oil sands monitoring program responds to this call by increasing the number of monitoring sites, the substances monitored, increasing the sensitivity of monitoring, providing standard methodology and will make this data publicly available. The details of this integrated program can be found on Environment Canada's website at www.ec.gc.ca/pollution/EACB8951-1ED0-4CBB-A6C9-84EE3467B211/Integrated%20Oil%20Sands_low_e.pdf

**Canadian Oil Sands Companies Collaborate for Environmental Performance**

In 2012, oil sands producers announced the formation of a new alliance to accelerate the pace of environmental performance improvement in Canada's oil sands.

The vision of Canada's Oil Sands Innovation Alliance (COSIA) is to enable responsible and sustainable growth of Canada's oil sands while delivering accelerated improvement in environmental performance through collaborative action and innovation.

Through COSIA, and starting with 12 major oil sands producers, the industry will work together with leading thinkers from industry, government, academia and the public to address environmental performance in four priority areas– tailings, water, land and greenhouse gases.

This is a milestone for our industry as companies who continue to compete with each other now bring together key parts of their intellectual property rights to work collaboratively on research and technology that will improve environmental performance and energy efficiencies. For more information on COSIA, please visit www.cosia.ca.

Canadian oil sands producers are advancing oil sands development in a manner that improves environmental performance, enhances energy security and contributes to economic growth for Canada and the United States. We strongly encourage an objective and balanced assessment of the oil sands' environmental activities and performance.

For additional resources, we have attached information on GHG mitigation strategies and environmental performance technology advances in Canada's oil sands, as well as information on the economic and energy security benefits of Canada's oil sands to the U.S.

CAPP CANADIAN ASSOCIATION OF PETROLEUM PRODUCERS

# CANADA'S OIL SANDS:
## PARTNERS IN AMERICA'S ENERGY FUTURE

## GHG emissions

**Carbon dioxide ($CO_2$) is a GHG. $CO_2$ is emitted into the air by burning fossil fuels for electricity generation, industrial uses, transportation and for heat in homes and buildings.**

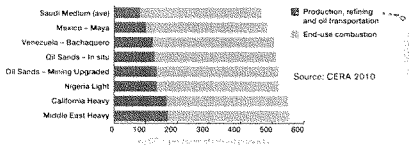
### Wells-to-wheels

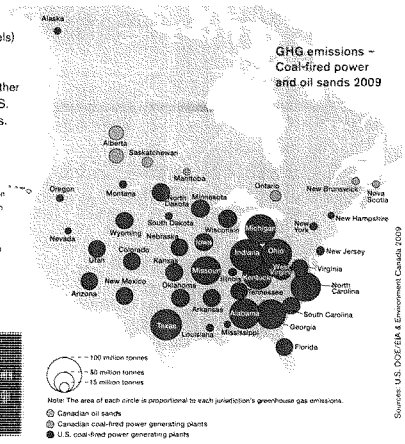
Measuring $CO_2$ emissions from the start of oil production (wells) through to combustion (wheels) is called a wells-to-wheels or life-cycle analysis.

### Intensity

Oil sands crude has similar $CO_2$ emissions to other heavy oils and is 6% more intensive than the U.S. crude supply average on a wells-to-wheels basis.

**Wells-to-wheels CO2 emissions from various sources of crude**




## GHG regulations

### Regulated

Of the top five sources of imported oil to the U.S. (Canada, Mexico, Saudi Arabia, Nigeria and Venezuela) Canada is the only country that currently has GHG regulations in place. Source: U.S. EIA

### 12% mandatory reductions

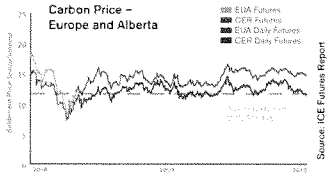
The Government of Alberta implemented GHG regulations in 2007 (the first jurisdiction in North America to do so) requiring a mandatory 12% reduction in GHG emissions intensity for all large industrial sectors including existing oil sands facilities, or a payment in lieu (current carbon price is $15/tonne).

### CCS

The Federal and Provincial governments are investing approximately $3 billion to help make Canada a global leader in carbon capture and storage (CCS) technology. Industry and government are cooperating to demonstrate the commercial and technical viability of CCS in Canada. Source: Alberta Environment

### Carbon price

Alberta's carbon price is similar to European daily futures carbon credit system. The current carbon price in Alberta is $15/tonne. Oil sands producers are required to pay into a technology fund if they do not meet the emissions reduction targets.

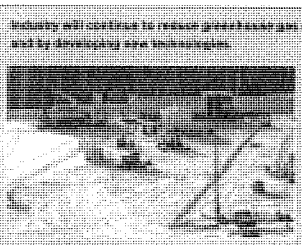


CAPP CANADIAN ASSOCIATION OF PETROLEUM PRODUCERS

# CANADA'S OIL SANDS:
## TECHNOLOGY AND INNOVATION

## IMPROVING ENVIRONMENTAL PERFORMANCE

The following are a sample of the many innovations industry is currently testing and using to reduce the environmental impact of oil sands development. For a more complete list of oil sands technologies and innovation, please visit oilsandstoday.ca.



### LESS STEAM IN SAGD

### REDUCING GREENHOUSE GAS

### FORESTS, FASTER

LAND

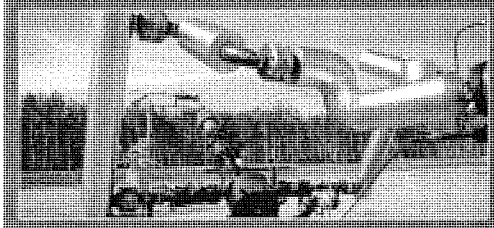
CAPP CANADIAN ASSOCIATION OF PETROLEUM PRODUCERS

# CANADA'S OIL SANDS:
## TECHNOLOGY AND INNOVATION

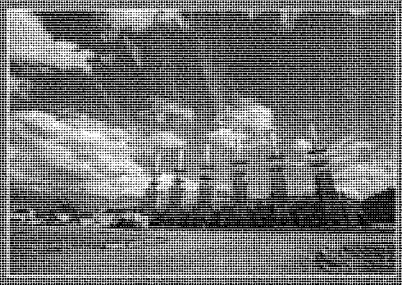
WATER

### TAILINGS REDUCTION

### RECYCLING WATER WITH ZERO LIQUID DISCHARGE



### USING UNDRINKABLE SALINE WATER IN SAGD

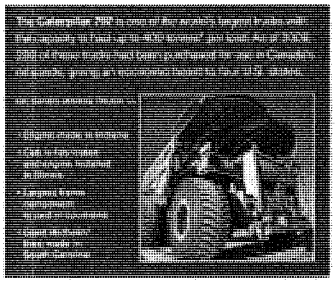


CAPP CANADIAN ASSOCIATION OF PETROLEUM PRODUCERS

# CANADA'S OIL SANDS:
## PARTNERS IN AMERICA'S ENERGY FUTURE

## ECONOMIC CONTRIBUTION

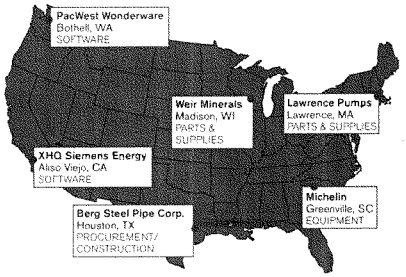
**Partner benefits** | Canada and the U.S. share the world's largest trading relationship. As a result, Americans benefit economically from increased economic activity in Canada. When investment and production ramps up in Canada's oil sands, the pace of economic activity quickens and demand for U.S. goods and services increases.



"The energy relationship between Canada and the U.S. is mutually beneficial economically. The money our country spends on Canadian oil is regularly reinvested through the purchase of American goods and services for oil sands projects. American citizens also benefit through their pension and retirement fund investments."

- David Wilkins, former U.S. Ambassador to Canada

**Businesses** | Examples of American companies supplying Canada's oil sands:

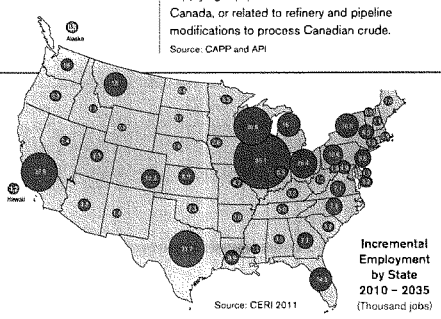



**2400 companies** | More than 2,400 American companies from 49 states are already involved in the development of Canada's oil sands by either supplying equipment and services used in Canada, or related to refinery and pipeline modifications to process Canadian crude.

Source: CAPP and API

## JOBS

**Across the U.S.** | Every U.S. state will benefit economically* from oil sands development and production. Induced impacts to the economy provide significant ripple effects, creating employment in numerous U.S. industries not directly related to the energy sector. Source: CERI 2011



**Incremental Employment by State 2010 – 2035**
(Thousand jobs)

Source: CERI 2011

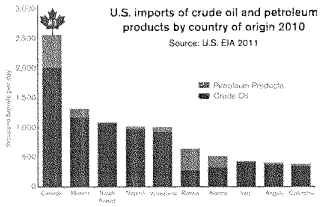
*Economic benefits are direct, indirect and induced.

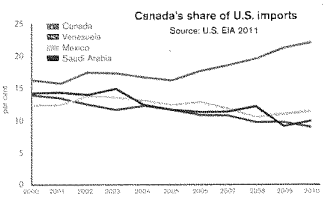
CAPP CANADIAN ASSOCIATION OF PETROLEUM PRODUCERS

# CANADA'S OIL SANDS:
## PARTNERS IN AMERICA'S ENERGY FUTURE

## CURRENT ENERGY SUPPLY

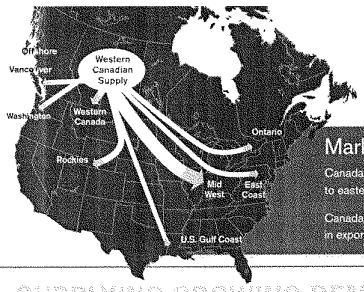
**Trusted neighbors** | Canada is the largest supplier of crude oil and petroleum products to the U.S.




**Security of supply** | Canada has abundant resources, production is growing, political stability is high, cross-border infrastructure is robust and environmental standards are high.

"The United States and Canada have a longstanding history of being trusted neighbors and friends. This is no more evident than in the deep energy relationship between our two countries and given the continuing global uncertainties a relationship that is poised to grow even deeper, to our mutual benefit." - Gordon Giffin, former U.S. Ambassador to Canada




### Markets

Canada has the infrastructure to export crude oil from western Canada to eastern Canada, the U.S. and some offshore markets.

Canada's oil sands industry continues to pursue opportunities for growth in exports to the U.S. and market diversification to new markets in Asia.

## SUPPLYING GROWING DEMAND

**Our energy future** | The world relies on an energy mix that includes oil, coal, natural gas, hydro, nuclear and renewables. All forms of energy production must increase to meet growing demand.

**Global needs** | Global demand for energy is expected to increase 53%* by 2035 as economies in both developed and emerging countries continue to grow and standards of living improve. Source: U.S. EIA 2011 *Growth from 2008 to 2035, Reference Case scenario.

**Investment** | The majority (79%) of world oil reserves are owned or controlled by national governments. Only 21% of total world oil reserves are accessible for private sector investment, 56% of which are found in Canada's oil sands. Source: CAPP 2011